# Animals, Environment, and Society: A zooarchaeological approach to the Late Chalcolithic – Early Bronze I transition in the southern Levant

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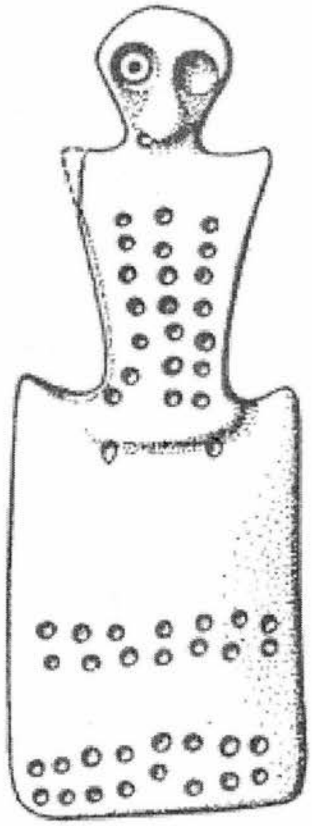

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## ABSTRACT

The Chalcolithic-Early Bronze I (ca. 4500-3000 BCE) in the southern Levant saw significant social, political, and economic changes, evidenced by changing architectural styles, settlement patterns, and material cultures. Developments in the Chalcolithic and Early Bronze I gave way to the first walled settlements in the Early Bronze II, sometimes termed the first "urban" period in the southern Levant. This study investigates the animal component of the subsistence economy during the Chalcolithic and Early Bronze I in the southern Levant. In light of the proposed social, political, and economic changes occurring at this time, certain changes in the use of animals and their products are proposed. Zooarchaeological data are used to address three research themes: 1) the nature and degree of change in the transition from the Chalcolithic to the Early Bronze IA, including evidence within the animal economy that might help explain the Chalcolithic collapse; 2) zooarchaeological distinctions between the Early Bronze IA and IB, two discrete phases which are rarely separated in zooarchaeological studies; and, 3) a zooarchaeological assessment of the relationship between Egypt and the southern Levant from its incipience in the Chalcolithic to its climax in the Early Bronze IB.

Zooarchaeological assemblages from three southern Levantine sites are used as the basis upon which to explore the aforementioned research themes. Shiqmim is a Chalcolithic (ca. 4500-3700 BC) village in the Beersheva area of the northern Negev. Afridar is an Early Bronze IA (ca. 3600-3300) site encompassing three excavation areas (Areas E, F, and G) located on the southern Coastal Plain of Israel, north of Ashkelon. The Halif Terrace, a site located on the northern Negev-southern Shephelah interface, provides animal bones from Early Bronze IA and IB (ca. 3600-3000 BC) contexts.

Standard zooarchaeological methods are employed to facilitate inter-site comparisons. Resulting data pertain to: defining environmental limitations and constraints that might affect human decisions regarding the subsistence economy;

assessing human consumption of primary animal products, specifically meat; defining the use of secondary products of animals, such as milk, wool/hair, and labor; and, finally, evaluating patterns of discard of animal remains across settlements.

Results indicate that meat and secondary products provisioning occurred on a household basis from the Chalcolithic through the Early Bronze IB. However, changes in animal use noted between sites and over time at Shiqmim, Afridar, and the Halif Terrace indicate changing subsistence strategies within the limits of household production. The varying strategies indicate how the Chalcolithic and Early Bronze I people related to environmental limitations and changes in stability in light of the changing socio-political situations. Evidence from the later Early Bronze IB indicates a particularly significant change towards more intensified use of sheep/goat. The animal economy has also been found to serve as a catalyst for change—in the case of the donkey, whose increased presence corresponds, not coincidentally, with increasing contact with Egypt. Zooarchaeological analyses are therefore found to build upon our interpretations of the nature and degree of change from the Chalcolithic through the Early Bronze IB.

# DECLARATION

I declare that this thesis has been composed by me
and that the work contained within it has been conducted by me.

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For my parents,
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# Chapter 1

# Introduction

## 1.1 Nature and order of presentation

My first excavation experiences were at Shiqmim and the Halif Terrace in Israel. The degree of dissimilarity in material culture at these Chalcolithic and Early Bronze I sites was striking. It struck me that there must be variations within animal exploitation that are as marked as those visible variations seen in the ceramics, flint, and architecture from these two periods. These early excavation experiences of mine can be seen as the inspiration for the present work. As I explore the discipline of zooarchaeology, I am constantly reminded of the great potential for zooarchaeological analysis to provide both a unique perspective as well as complementary data for the study of early complex societies. This work reflects my first steps in the field of zooarchaeology, and follows my efforts over four years of zooarchaeological endeavors. I see this work as setting the stage for continuing investigations into the animal economy of early complex societies.

After a brief overview of the contents of each chapter, Chapter 1 defines key terminology used throughout the work. The final section of Chapter 1 presents the three research areas to be addressed using the animal bone assemblages chosen for this study. It also briefly describes test predictions for the application of zooarchaeological data to these research questions.

Chapter 2 provides a background to zooarchaeological studies from the Chalcolithic and Early Bronze Age of the southern Levant. Specific attention is given to those studies that have incorporated inter-site or diachronic assemblage comparisons. The nature of the data available to date is not particularly conducive to a thorough investigation of the proposed research questions. The second part of Chapter 2 elaborates on the three research themes that are the essence of this study.

For each area of investigation, it details archaeological evidence, describes the prevailing theories, and presents predicted outcomes for the use of zooarchaeological data in investigating these questions.

Chapter 3 details methods used to analyze the local environment, meat consumption, secondary products exploitation, and discard. Standard zooarchaeological methods are used to promote comparison with other assemblages and to provide useful data for future analyses. The layout of this chapter mirrors that of Chapter 5 (Results). The similarity in structure is intentional to ease the reader's perusal of the results by providing a clear reference to the corresponding methods of analysis.

Chapter 4 describes the materials for analysis. This includes laboratory and reference materials, as well as a description of each of the three animal bone assemblages used for this study. Four elements of each assemblage are described: location and environment, site lay-out and chronology, excavation and animal bone assemblage, and limitations of the material. The applicability of the chosen assemblages to the present study is also discussed.

Chapter 5 presents the results from each of the three sites under study. Results pertain to the location of the site, animal consumption (the use of primary products), secondary products exploitation, and discard. The results are synthesized in Chapter 6, where they are placed in the context of the three research themes from Chapter 2.

Chapter 7 summarizes the results of this study and discusses areas for future research. It emphasizes the importance of interdisciplinary studies in archaeological interpretation, and promotes the use of intra-site spatial analysis for investigating human behavior at the household level. It also calls for further research into the origins, use, and spread of the domestic donkey.

## 1.2 Definition of key terms

### 1.2.1 Archaeological terminology

#### 1.2.1.1 Chalcolithic-Early Bronze I chronology

This study focuses on the Northern Negev and southern coastal region of the southern Levant during the Chalcolithic through the Early Bronze I (EB I), circa 4500-3000 BCE. The Chalcolithic Period in the southern Levant spans a time frame of about 1000 years, from about 4500-3600 BCE. Archaeological investigations in this area indicate that a decline of the long-standing Chalcolithic way of life around 3900-3700 BCE (Joffe and Dessel 1995) was followed by significant socio-political, economic, and demographic changes in the subsequent Early Bronze I period (specific characteristics of these two periods are discussed later). Because of these significant changes, some have suggested a three to four hundred year gap between the two periods in the Beersheva area (Gilead 1988). However, radiocarbon dates suggest that the final phase of the Chalcolithic in the Beersheva area continued to about 3700-3500 BCE. Thus, if the Late Chalcolithic ended by 3500 BCE, and the earliest EB I is dated at or earlier than 3500BC (Joffe and Dessel 1995), there would be, at least in some areas, a significant overlap between the two periods.

Recent assessments of the radiocarbon dates from the two periods have extended the end of the Chalcolithic and the beginning of the Early Bronze Age so that the chronological gap between the two is much narrower than was previously thought. For example, Stratum I dates from Shiqmim indicate that the latest reoccupation of the site was around 3700 BCE (Joffe and Dessel 1995), and the latest dates for the Late Chalcolithic are from the Nahal Mishmar hoard and fall around 3500 BCE. Joffe and Dessel's (1995) recent compilation of radiocarbon dates from Southern Palestine and Lower Egypt indicates that the Chalcolithic decline occurred from 3900/3800-3700 BCE, and that the end of the Chalcolithic, or the "Terminal Chalcolithic", took place from 3700-3500 BCE. These latest Chalcolithic dates might overlap the incipience of Early Bronze Age forms around 3600 BCE.

However, these "Late Chalcolithic" and "Terminal Chalcolithic" interpretations are still tentative, as they are not supported by well defined changes in material culture.

Beginning in the Late Chalcolithic, we are able to link the chronology of the southern Levant with that of contemporary sites in Lower Egypt for the first time. The site of Ma'adi in lower Egypt finds an architectural similarity with the northern Negev in subterranean and semi-subterranean dwellings (Rizkana and Seeher 1989). Dates from Ma'adi fall in the Late Chalcolithic with some overlap into the EB I (Joffe and Dessel 1995), while pottery from the site is EB IA in typology (Caneva et al. 1987). The architectural similarities between the two areas, together with the occurrence of southern Levantine pottery and pottery with Chalcolithic southern Levantine forms in the Buto (Egypt) assemblages (Faltings and Köhler 1996), indicate that there was some kind of contact between the two areas as early as the Chalcolithic.

The Early Bronze Age spans a long period from about 3600 BCE to 2000 BCE, and can be sub-divided into phases EB I through EB IV/MB I, largely based on ceramic typologies (Stager 1992). This study focuses specifically on the first phase of the Early Bronze Age, the Early Bronze I (ca. 3600-3000 BCE). The Early Bronze I is sub-divided into earlier and later phases (Stager 1992), and calls these sub-phases Early Bronze IA (EB IA) and Early Bronze IB (EB IB). Braun (1996:20) largely agrees with Stager's differentiation of sub-phases in the EB I, but sees too much continuity between them to warrant the terms "EB IA" and "EB IB". However, for the sake of clarity, this study uses the terms EB IA and EB IB. The Early Bronze I is thought to have begun with the collapse of the Ghassulian Chalcolithic, a phenomenon that has yet to be explained, resulting in unclear boundaries between the Late Chalcolithic and the EB IA. It appears that the subsequent EB IA in the south saw some continuation of traditions from the previous Chalcolithic. Threads of evidence for this intermingling is found in most aspects of the material culture of the two periods, including pottery, chipped stone, architecture, and burial traditions (Braun 1996:20-26). The EB IA gives way to the

EB IB, the later half of which sees a heightened presence of Egyptian and locally-made Egyptian artifacts in the southern Levant, indicating some kind of relationship between the two regions (Gophna 1995:227). The EB IB terminates along with a disappearance of the Egyptian presence, and the subsequent EB II phase sees the rise of the first walled settlements in the southern Levant. This study follows the approximate dates for the Chalcolithic through the Early Bronze IB, taken from a variety of sources: Chalcolithic: ca. 4500-3600 BCE; Early Bronze IA: ca. 3600-3300 BCE; Early Bronze IB: ca. 3300-3000 BCE (Joffe 1993:41; Joffe and Dessel 1995; Levy 1995:226; Gophna 1995:269).

1.2.1.2 The Chalcolithic: General Characteristics

Defining characteristics of the Chalcolithic (ca. 4500-3700 BCE) show a high degree of uniformity throughout Israel. However, regional variations exist depending on environment and access to raw materials (Gonen 1992). This study focuses on the southern aspect of the Chalcolithic, particularly in the Beersheva region. The Chalcolithic period in this part of the southern Levant (ca. 4500-3700 BCE), and particularly the latter portion of the period, is generally characterized by an increase in the number and size of settlements from the Neolithic, especially in the northern Negev region. There are still many small settlements; however, the emergence of large village communities is a key aspect of the Chalcolithic. Their emergence in the Chalcolithic was accompanied by higher degrees of specialization as illustrated by elaborate ivory carving, copper metallurgy, and other well-crafted objects (including "cultic" and "prestige" objects), flood-water irrigation of agriculture, the appearance of cult centers, and the intensive exploitation of the secondary products of animals (Levy 1992b; Sherratt 1981; Stager 1992). It is in the northern Negev that we see the emergence of the rich Beersheva Chalcolithic culture, which provides much of our knowledge of this vibrant phase in the prehistory of the southern Levant. Sites in this area (Shiqmim, Bir es-Safadi, T.Ghassul, to name but a few) have provided a wealth of materials typical of the Chalcolithic cultures of this region such as ivories, violin-shaped figurines, and copper objects. The Chalcolithic populations, especially of the Beersheva area, are thought to have had complex features, such as specialized craft production, religious institutions, and a two-tiered settlement hierarchy (Levy 1995).

Perhaps the most outstanding feature of Chalcolithic society is the high degree of specialization in making 'prestige' objects. The extreme importance of these objects and of the skill involved in their manufacture is brought to the forefront by such objects as the Beersheva ivories; basalt sculptures from the Golan; painted ossuaries in the shape of houses with anthropomorphic heads; zoomorphic and anthropomorphic figurines carrying baskets and churns; copper mace heads, 'standards', 'crowns', and other objects; violin-shaped figurines; and, wall paintings from T. Ghassul (Cameron 1981). Additionally, Levy argues for the emergence of a two-tiered settlement hierarchy in the Chalcolithic. This is based on his observations of site size and distribution in the Beersheva area and on the coastal plain, and is characterized by large villages centers and smaller dependent satellite sites (Levy 1995:229). These features of Chalcolithic society argue for a complex and organized population, which Levy terms a chiefdom, that successfully persisted in the Northern Negev for over 600 years.

The Chalcolithic in the northern Negev has been described as consisting of mixed farming communities, where agriculture and animal keeping are integrated (Gilead 1988). Sheep, goats, cattle, and sometimes pigs are kept, and although there is probably some movement of animals, it is very limited (Grigson 1995). Levy (Levy 1992b) sees the Chalcolithic in the northern Negev as a stratified society undertaking what he calls village-based transhumance, involving seasonal movements of flocks as an optimization strategy for better pasture (Levy 1992b). This type of system implies a lower level of integration of farming and animal husbandry, with specialized herding activities occurring for at least part of the year. While sheep, goats, and cattle are used in roughly equal numbers in this type of system, it is thought that pigs are not an element of this system (Grigson 1995). This is largely because pigs are not well-adapted to the partial seasonal transhumance which characterizes this scheme[1]. Gilead (1988) proposes an alternative theory involving a lesser degree of movement. He sees the Chalcolithic settlements as less stratified, permanent villages with peasants practicing dry farming and animal husbandry, taking their flocks no more than 15 km from the village (Gilead 1995). Grigson (1995:264, Figure 1.1) suggests that the Chalcolithic communities most likely took part in a spectrum of activities, largely dependent on the local environmental constraints and the uses to which animals could be put (Grigson 1995:248).

### 1.2.1.3 The Chalcolithic-Early Bronze I transition

The nature of and impetus for the Late Chalcolithic - Early Bronze I transition (3700-3500BC) is not well understood. Studies concerning the transition all suggest that there are certain determinable differences between the two periods (reviewed in section 2.2.1.1). These differences vary by region; in some places the changes are significant, while in others they are more difficult to discern (Braun 1996). This discussion focuses on characteristics of the Chalcolithic and the Early Bronze I in the northern Negev foothills, the Beersheva area, and the southern coastal plain. However, since the degree of continuity between the two periods varies from region to region, it is important to view the research area in light of the Chalcolithic-EB I transition in the greater region of the southern Levant. Section 2.2.1, which discusses continuity and change between the Chalcolithic and the Early Bronze IA, draws upon evidence from regions outside the main area of study in order to highlight the regional variation.

The transition from the Chalcolithic to the Early Bronze I is marked most significantly, on a broad, regional level, by a demographic change. Where the southern aspect of the Chalcolithic flourished in the northern Negev, Early Bronze I settlements proliferated throughout the Mediterranean zone, especially in the

[1] Recent findings (Zeder 1996) cite instances where pigs were involved in long-distance drives. This may indicate that pigs might have been involved in some degree of seasonal movement.

foothills and highlands (Stager 1992). Beginning around 3700BC, the Chalcolithic traditions which had persisted for nearly a millennium in the southern Levant began to decline. About 3500BC the majority of the hallmark features of Chalcolithic society had disappeared. Most notable in this transformation is the abandonment of the majority of the Chalcolithic sites in the southern Levant, in particular the Beersheva area, where collapse was almost complete. The ensuing Early Bronze I period is characterized by an apparent return to small village life, in which some Chalcolithic traditions continue. However, the evidence for elites, production of certain pottery types, and the production of "prestige" objects so prevalent in the Beersheva Chalcolithic disappears from the archaeological record (Joffe 1993:41; Ben-Tor 1992:84).

The end of the Chalcolithic is marked by the abandonment of many sites and a major shift in settlement patterns (Braun 1996; Joffe 1993). The Chalcolithic collapse in the Beersheva area was nearly complete, but nevertheless there are some indications of continuity into the Early Bronze I. Braun's thorough research on the chronology and material culture of the Chalcolithic and Early Bronze I from this area indicates that "it is very unlikely that there could have been a gap of centuries between the end of the Beersheva sites and the initial EB I sites" (Braun 1996:7). While Braun emphasizes the distinctiveness of the Chalcolithic and Early Bronze I, he admits that there is some overlap suggesting that the gap between them is much narrower than was previously thought (Braun 1996:13). This indicates a certain degree of continuation of the local population, despite the significant material cultural and settlement changes that were taking place.

#### 1.2.1.4 The Early Bronze I: General Characteristics

The Early Bronze I probably spanned a longer time period than previously thought. It is now estimated that this period lasted four centuries or more (Braun 1996:30). The variation within the Early Bronze I indicates a loosely defined cultural tradition, but held together by a common cultural thread throughout the period, which can be traced in various aspects of EB I archaeological materials (Braun 1996:31). Following the Chalcolithic collapse, the initial phase of the Early Bronze I, the EB IA, is a period of less well-defined political and social organization, witnessing an apparent break-down in certain types of specialization seen during the Chalcolithic. Many of the Chalcolithic "prestige" copper objects, ivory objects, certain stone artifacts, painted ceramic ossuaries, and figurines and ceramics associated with milking disappeared at the onset of the Early Bronze IA. In their place appears more utilitarian copper objects, produced presumably for wider use (perhaps, though, still requiring specialized knowledge). This abrupt change in the smelting, composition, and repertoire of copper objects implies a significantly dynamic change in copper production into the Early Bronze IA. The EB IA also sees cruder, more varied ceramic styles, indicating less contact between regions and less specialized ceramic production. The transformation to the Early Bronze I is evidenced in a shift in architectural traditions. Rectilinear Chalcolithic architecture gave way to a predominance of curvilinear buildings in the EB IA, which was followed by a return to rectilinear buildings again in the EB IB (Braun 1996)[2]. The use of curvilinear buildings in the EB IA might indicate less site planning and a looser social organization. The Early Bronze IA also saw a change in settlement patterns, focusing on hilly areas with 400mm or more of rainfall annually, contrasting with the Chalcolithic settlement pattern where people seem to have preferred open terrain in more marginal areas. In sum, evidence points to a lesser degree of social complexity, looser social organization, and little social differentiation in the Early Bronze IA than in the preceding Chalcolithic (Gophna and Portugali 1988; Joffe 1993; Levy et al. 1997).

The latter half of the Early Bronze I, the EB IB, sees a return to more stable and less ephemeral population groups again, with a tighter political and social organization than in the preceding EB IA, implying a more sedentary community

[2] Buildings associated with religious activities remain rectilinear throughout the Chalcolithic-EB IB (Ben-Tor 1992).

committed to long-term occupation (Joffe 1993:50). Sporadic contact between the southern Levant and Egypt from as early as the Chalcolithic climaxed in the EB IB. This heightened contact is evidenced in southern Levantine sites with abundant Egyptian and locally-made Egyptian-style pottery and chipped stone tools (Levy et al. 1997; Rosen 1988). The evidence points to Egyptians living in the southern Levant at this time, side by side in settlements with local Canaanites, and involving some kind of commercial activity, such as the export of southern Levantine goods to Egypt (Ben-Tor 1991; Levy et al. 1997). The evolution and characteristics of the relationship between Egypt and the southern Levant during the Chalcolithic and the EB I is discussed in depth in Section 2.2.3.

A number of innovations that characterize the Early Bronze I include increased use of the domestic donkey (found only rarely in Chalcolithic animal bone assemblages), intensified olive and grape horticulture, a movement into different settlement areas, and an increasing contact with Egypt. The "Mediterranean revolution" (Stager 1992) of the Early Bronze I saw the emergence of the triad of horticulture, agriculture, and sheep and goat husbandry that became characteristic of the southern Levantine economy for thousands of years since. Some argue that the Early Bronze I, rather than the Chalcolithic, saw the first *intensive* use of secondary products (Horwitz and Tchernov 1989; Smith and Horwitz 1984). The social, economic and demographic developments during the EB I eventually led to the establishment of the first walled towns during the EB II.

The characteristics of the Early Bronze Age vary greatly from north to south. This is especially true of the Early Bronze I, whose early phase involved a time of loose political and social organization, and whose later phase involves a unique relationship with Egypt which did not reach the northern settlements. For this reason, this study focuses strictly on the southwestern EB I, the area of the southern coastal plain and the southern Shephelah, encompassing both Afridar and the Halif Terrace, two of the three sites involved in this study. This area also indicates an extended period of overlap between the final phases of the southern Chalcolithic and the earliest indication of the southern EB IA (Gophna 1995:272). The faunal evidence between Afridar (earliest EB IA) and Shiqmim (Chalcolithic) is particularly useful considering the imprecise period of overlap in the area.

### 1.2.2 Zooarchaeological terminology

#### 1.2.2.1 Animal economy

Zooarchaeologists usually talk about "subsistence" in reference to the basic food needs of people and the realm of human-animal interaction involved in procuring food products. The term "subsistence" becomes misleading, however, when describing complex societies where animal-related activities move from basic subsistence to market and redistributive economies. This investigation of the human-animal relationship in the Chalcolithic and Early Bronze Age involves a spectrum of animal-related activities and all animal products exploited by humans. This includes basic subsistence production of food and clothing. However, it also has another aspect involving animal exploitation for accumulation of wealth (wool production), trade (use of donkeys for labor), and companionship or protection (dogs). A term is needed to refer to the entire spectrum of animal-related activities. This study therefore uses "animal economy" to refer to the *entire* corpus of activities involving the use of animals, both for food and for secondary products such as wool for weaving, labor for agriculture, and dogs for herding, companionship, and/or protection.

#### 1.2.2.2 Environment

The first results analyzed in this study concern humans and their interactions with their environment. The environment is defined by Halstead and O'Shea (1989:2):

> "Human beings do not exist within a vacuum. Rather, their behaviour is constrained by their surroundings or environment. Their environment has three components: abiotic (physical-chemical surroundings), biotic (organisms of other species), and social

> (organisms of the same species). Needless to say, human beings mould all three components of their environment to a greater or lesser extent, so we are not concerned here with rival deterministic claims, but rather the interaction between man and his environment."

Following the definition above, this study recognizes environment (both natural *and* social), as providing the basis from which human decisions are made. Defining the limitations of this environment is therefore necessary before attempting to understand human decisions and behaviors regarding subsistence practices and other economic activities.

Our interpretation of these constraints is influenced by taphonomic factors, both natural and cultural (Lyman 1992), ancient and modern. Animal bones (ecofacts) are often subjected to a higher level of natural and human-caused taphonomic processes than are other artifacts. Human and natural taphonomic factors begin to take effect as early as the point of animals living around the site (Meadow 1981, Table 1). Taphonomic factors in this discussion, therefore, involve ancient activities (choice of animals to kill, butchery practices, dog gnawing), modern activities (choice of excavation area, retrieval procedures), and any natural or cultural activities in between (reoccupation of the site at a later time, movement of artifacts from alluviation or wind, disturbance by more recent plowing). All these factors and others affect which types of bones we find, where we find them, and their state of preservation. Due to the role of natural factors in bone preservation and resulting analyses, this study first approaches the environment in order to define limitations that might affect the resulting zooarchaeological assemblage.

#### 1.2.2.3 Consumption (primary products)

This study uses the term "consumption" in reference to any human activities involved in the use of an animal for meat. While meat is the main focus, this study also considers other primary by-products of an animal after it has been killed for meat. Such primary products include hides, horn, bone tools, and sinews.

1.2.2.4 Secondary products

The term "secondary products" was coined by Andrew Sherratt (1981) and refers to products that can be taken from an animal while it is still alive, such as milk, wool, hair, dung, and labor (Sherratt 1981).

1.2.2.5 Discard and distribution

In this study "discard" refers to the types of bones found in the archaeological record, their relationship to each other and to their archaeological context, and their state of preservation. Leaving natural taphonomic factors aside, discard is used here to tell us something about the way ancient peoples dealt with animal carcasses, whether for cooking, hides, or burial. In this study, discard involves two aspects. The first is primary discard, referring to parts which are removed during butchery and cast aside. This contrasts to secondary discard, which refers to discard after the parts have been used (cooked, crushed, boiled, and then cast away). "Spatial distribution" refers primarily to the lay-out of the archaeological bones; that is, how we find them distributed across the site. It does not refer to the distribution of food among ancient peoples at the site, but rather to the lay-out (distribution) of *their discard*. Where someone ate something is not necessarily (and hardly likely) the place they discarded it. In sum, discard refers to *what* people were discarding, while distribution refers to *where* they were discarding it.

1.2.2.6 Specialization

Defining specialized production in the archaeological record is of particular importance in this study when discussing levels of social complexity achieved during the Chalcolithic and the Early Bronze I. This study follows the definition of specialization put forth by Costin (1991:4):

> "Specialization is a differentiated, regularized, permanent, and perhaps institutionalized production system in which producers depend on extra-household exchange relationships at least in part for

their livelihood, and consumers depend on them for acquisition of goods they do not produce themselves."

Costin further defines specialization production as "differential participation in specific economic activities" which can be recognized "whenever there are fewer producers than consumers of a particular good" (Costin 1991:43). While production activities during the Chalcolithic and the Early Bronze I are generally seen as taking place on a household basis, there is potential for differential participation in specific economic activities, or specialization. In each period, consideration is given to the products which might have been produced by specialists, and in what socio-political context this production might have taken place. Possible areas where specialization might have occurred in the different periods include metal-working, ceramic production, production of prestige objects in a variety of materials, horticultural production, and animal husbandry.

Specialization can be defined as "the regular, repeated provision of some commodity or service in exchange for some other" (Costin 1991:3), of which differentiation and interdependence are crucial components (Brumfiel and Earle 1987:5; Lewis 1996). However, specialization encompasses more than this, one of its most important aspects being the affiliation of the specialists: attached or independent. Attached specialists produce goods or services (often luxury or wealth goods, what are considered "politically charged commodities" (Brumfiel and Earle 1987:5)) to meet the demands of an elite, patron, or institution, usually under close supervision in a restricted locality such as a workshop or palace. Independent specialists, on the other hand, produce goods or services (often utilitarian goods for circulation within the subsistence economy) for an unspecified demand that varies according to economic, social, and political conditions (Brumfiel and Earle 1987:5; Lewis 1996; Costin 1991). Attached and independent specialists are not a dichotomy, but rather "two different ends of a continuum in the degree of elite control over craft production" (Stein 1996:26). An important aspect of attached specialization that will become relevant in this study is "noncentralized attached specialization" (Lewis 1996) which involves attached specialists producing wealth or prestige objects for elites, but outside of direct supervision (in their household).[3]

Distinguishing attached and independent specialization is important because the type of specialization implies the demand or principles behind its incipience. Lewis (1996) suggests that only elite control (the demand imposed by elites on attached specialists) can explain the *origins* of specialization (but that specialization can then *develop* in the context of either attached or independent specialization). However, Stein (1996) argues that the control of elites over early craft specialization is overemphasized, finding in the Ubaid period (ca. 5500-3900 BC) in Mesopotamia evidence for the earliest craft specialization occurring not among attached specialists, but rather among independent ceramic specialists. Later, in the Late Uruk (late fourth millennium) at Warka (Uruk), both attached and independent specialists existed simultaneously. Attached specialists producing high-prestige goods were controlled by a centralized institution (most likely the temple), while both attached and independent specialists producing such items as utilitarian ceramics operated outside of centralized administrative control. Archaeological evidence is found for this arrangement in widespread ceramic production in outlying areas, indicating independent specialists, and concentrated prestige items (and their production debris) in the temple precinct of the city, indicating attached specialists. However, kiln waste was found not only in outlying areas, but also in the central area, indicating that some potters were probably attached specialists operating in the temple precinct of Uruk. Stein's study points out the relationship of attached and independent specialists to the issue of redistributive and market economies. While redistributive economies would be more likely to involve attached specialists and market economies independent
specialists, his study found that both types of economies existed at Warka, and therefore both types of specialists working for different demands. Unfortunately, the

[3] This type of specialization might be defined archaeologically when a high quality, high class item is found in a relatively low-status household removed from a centralized location (Lewis 1996).

available evidence concerning specialization in the Chalcolithic and EB I of the southern Levant is sparse. This study attempts a preliminary assessment of possible institutional attachments of people involved in the animal economy and the scope of the specialized activity (on a local, regional, or international scale).

This study places specific attention on the potential for activities related to animals or animal products to become specialized. I will argue that activities related to animal economy during the Chalcolithic and Early Bronze I were usually taking place on a household basis; that is, small-scale, kin-based groups undertaking production of a range of general needs (see also Joffe 1993:53). Production within the household unit *for* other members of the household might be specialized according to age or sex, but do not fall within our definition of specialization here. However, certain of those activities have the potential to become specialized, providing products or services to others outside the immediate household. This study proposes that certain animal products, even certain perishable ones, can become specialized (although the perishable products would be limited in distribution). For example, the type of local to regional milk-based system proposed for the Chalcolithic (described in Section 2.2.1.4.1) might have involved a specialized milking strategy for the fulfillment and maintenance of ties within the system or network.

This study uses sheep/goat kill-off patterns to determine the likelihood that certain sheep/goat products were being produced for extra-household consumption. It is difficult to determine what was being exchanged for the goods or activities provided. We can assume that when specialized activity focuses on one product, another product will be needed in exchange. This study sees specialization in sheep/goat products as occurring at the point where production intensifies to the point that there must be extra-household consumers in order to make the level of production viable. For example, specialization in sheep/goat wool production occurs when wool is the primary concern, and is being selected for at the expense of other products, such as meat. It can then be assumed that the wool specialists were exchanging the wool for some other product(s), and perhaps even relied on others to provide them with certain subsistence foods. This demonstrates the distinction in this study between "specialization" and "intensification": specialization produces more of one good and less of others so that exchange is required for survival; intensification is seen as a step toward specialization, where a group can intensify production, but remain self-sustaining without exchange of good or services from others.

Another potential area of the animal economy where specialization on a non-household basis might occur is in pastoral activities. Pastoral activities during the Chalcolithic and Early Bronze I might have involved a partial or seasonal differentiation of the pastoral component of society from the settled component. A range of activities can be expected, among which are the following:

- *semi-nomadic pastoralism*, involving seasonal transhumance of part of the population
- *herdsman husbandry*, involving the tending of livestock by herdsmen away from the site year-round allowing the sedentary component of society to remain continually sedentary and engage in agricultural activities (Khazanov 1984:22)
- *mixed farming*, agricultural activity and very little movement of flocks (Grigson 1995)

The further differentiated a pastoral component becomes, the more specialized their activities become, and accordingly, the more interdependent they become on the settled component of society to provide them with other needs (and vice versa).

In sum, the term "specialization" throughout the text refers to differentiated production activities. The producer is outnumbered by the consumers and is producing goods or services for use or exchange *outside* the household on a regular basis to an extent whereby the producer become dependent on others (as they do on him) for subsistence and other goods. "Specialization" here does not include specialized activities within the household unit according to age or sex. On a final note, caution is taken throughout the text when discussing specialization of animal-related activities. When the activity cannot be determined to be specialized according to the above premises, the terms "intensification" and "focus" are used instead of specialization so as to not confer a weighted terminology on activities that might be not be considered specialized.

## 1.3 Research aims

### 1.3.1 Purpose of study

The Chalcolithic through the Early Bronze IB (ca. 4500-3000 BCE) saw significant socio-political changes. Elements of social complexity in the Chalcolithic (ca. 4500-3600 BCE) of the Beersheva basin gave way in the Early Bronze IA (ca. 3600-3300 BCE) to a period of looser socio-political structures. The Early Bronze IA, in turn, gave way to a period of increased sedentism and agglomeration of populations into larger settlements in the Early Bronze IB (ca. 3300-3000 BCE). Following the Early Bronze IB, the first walled towns emerged in this area in the Early Bronze II. The aim of this study is to determine whether indications of the changing socio-political climate during this long period of transition can be detected in changing activities involving subsistence and other aspects of the animal economy.

Animal bone assemblages chosen for this study come from settlements located in three adjacent environmental zones of the southern Levant. The assemblages represent the remains of human activities regarding animals and animal products that made up the animal economy during three sequential phases spanning the Chalcolithic through the Early Bronze IB. Briefly, Shiqmim is a Chalcolithic site in the semi-arid Irano-Turanian area of the northern Negev desert. Afridar is an early EB IA site located in the Mediterranean zone of the southern coastal Levant. The Halif Terrace represents the Early Bronze IA and IB, and is located in the area of interface between the southern Mediterranean coast, the northern Negev desert, and the southern Shephelah. The location, excavation, and animal bone assemblages from these sites are described in detail in Chapter 4.

The chronological span of Afridar and the Halif Terrace overlap in the Early Bronze IA. While I could avoid this overlap by omitting the Halif Terrace's EB IA material, I have chosen to include it for two reasons. First, the EB IA from the Halif Terrace, together with the two EB IB phases, provides important information about animal exploitation in the different phases of the Early Bronze I in light of the paucity of zooarchaeological analyses of distinct Early Bronze I sequences. Additionally, the data from a nearby and secure EB IA occupation will provide a useful comparison to the more chronologically confounding EB IA Afridar sites (discussed in Chapter 4).

### 1.3.2 Research questions and predictions

This section introduces the three research areas that will be addressed in this study. Each of the numbered sections below begins with a brief review of the research question. This review is followed by an abbreviated description of hypotheses (referred to as "predictions") regarding the application of the research questions to animal exploitation and zooarchaeological analysis. Detailed background information to the research questions and in-depth descriptions of test predictions are presented in Chapter 2 (section 2.2).

The purpose of this study is to determine to what extent the three research questions can be approached using zooarchaeological data. Predictions have therefore been devised to specifically deal with the range of possible outcomes of analysis on the faunal data presented in the upcoming chapters. An important factor to keep in mind is the equifinality of many of the zooarchaeological results, an issue that will be discussed as it pertains to interpretations in Chapter 6.

1) **Elements of change from the Late Chalcolithic to the Early Bronze I:** The first part of this question involves the degree and nature of change between the Chalcolithic and the Early Bronze IA. Different magnitudes of change within the socio-political sphere have been proposed for the Chalcolithic – Early Bronze I transition. Among these are a return to small village life in the EB IA, a disappearance of Chalcolithic "prestige" objects, and a transformation in the use

and distribution of copper objects. These changes have been associated with a proposed shift from larger-scale corporate ownership in the Chalcolithic to smaller-scale household ownership in the EB IA, as well as a shift from more symbolic goods in the Chalcolithic to an emphasis on commercial value of goods in the EB IA. Does zooarchaeological analyses provide support for any of these proposed changes?

The second part of this research question deals with the Chalcolithic collapse. Three main explanations have been given for the collapse of the Chalcolithic way of life by the middle of the fourth millennium BCE. The explanations include: climatic fluctuation; a breakdown of related political, economic, and social structures; and commercialization involving increasing contact with Egypt. How are any of these explanations reflected, if at all, by changes in the animal economy that supported these Chalcolithic societies? How can we differentiate between these different causes?

**Predictions:** Zooarchaeological evidence for social complexity in the Chalcolithic might be found in specialized activities regarding animals, such as in secondary products exploitation. A return to small village life in the Early Bronze IA might manifest itself zooarchaeologically in a return to a more generalized, household-level subsistence activities. These types of activities would involve exploiting a range of taxa mainly for meat and some non-intensive secondary products use. A change from more symbolic goods in the Chalcolithic to increased importance placed on commercial value in the EB IA may be detected in changes in specialization, such as a focus on different products like wool. Variations in butchery patterns and the spatial distribution of meat cuts may provide evidence for changes in ownership, such as the proposed shift from large-scale corporate ownership in the Chalcolithic to smaller-scale household ownership in the EB IA. Increased exchange and contact with Egypt during the EB IA is a significant difference between the Chalcolithic and the EB IA and is addressed in its own section (research question 3, the EB I relationship with Egypt).

Regarding the Chalcolithic-EB I transition, the type of instability caused by climatic fluctuation would see changes in risk management strategies, such as a change in resource utilization and storage, and increased mobility and exchange. If climate change were involved, we might expect to see the Early Bronze I populations employing certain risk reduction strategies to cope with this instability. Among the strategies they might have employed is diversification in resource exploitation, evidence for which might be found in a more diverse assemblage of taxa (exploited to secure subsistence resources during a time of climatic changes). We might also expect to see fluctuations in the ratio of sheep to goat among herds, depending on the climatic shift. Other strategies include increased storage, increased mobility, and exchange. While storage is difficult to detect zooarchaeologically, increased mobility might be seen in an increased focus on sheep/goat, who lend themselves to mobility. We might also expect to see a decrease or absence of pigs, who imply a certain degree of sedentism (though environmental factors also play an important role in pig-keeping, as will be discussed later). Related to mobility is evidence for increased exchange which might be found in the use of donkeys as a means of transport.

Mobility and exchange as methods by which to cope with instability may have played a role in the increased exchange contacts between Egypt and the southern Levant during the EB I. If commercialization involving Egypt contributed to the Chalcolithic collapse, we might find evidence in the increased use of certain taxa and age groups for export (on the hoof) or secondary products (wool, hair). The commercialization model also proposes a change in the socio-political order, from a system based heavily on symbols to one based on commodities. In light of this proposed change, we would expect to see zooarchaeological evidence for a change from animals or products related to the symbol-based Chalcolithic system, to animals or products that would facilitate a commodities-based system during the EB IA.

2) **Variations within the Early Bronze Age economy:** The Early Bronze IA and IB are rarely distinguished in zooarchaeological studies. However, archaeologists have noted significant differences between the two periods, such as increased sedentism, the agglomeration of populations into larger settlements, and a significant shift in the nature of the contact with Egypt in the Early Bronze IB (discussed below). Can these socio-political and demographic changes be detected in changes in the animal economy from Early Bronze IA and IB settlements?

**Predictions:** The picture of the EB IB socio-political situation involves more involvement in regional and international contacts and the development of specialists in an increasingly complex population. Inter-regional contact and exchange and increasingly dense populations would certainly have effects on production strategies within the animal economy. One of the possible outcomes of increased sedentism and agglomeration of populations into larger settlements is the development of a specialized pastoral component of society. The existence of specialized herders who are to some extent dependent on the settled portion of society (and vice versa) would encourage specialization in other areas, such as secondary products provisioning and more intensified production. Evidence for specialized pastoral activities and secondary products production should be found in demographic changes, particularly among sheep/goat.

Increased population density requires increased food production, which is one of the reasons for the removal of pastoral activities away from the site. It is also incentive for increased involvement in agriculture. Evidence for intensified agricultural or horticultural activity might be found in the use of cattle for draught or in fluctuations in pig exploitation over time.

3) **Interaction with Egypt:** While contact between the southern Levant and Egypt existed since at least the Chalcolithic, the nature of this contact shifted in the Early Bronze I (and particularly in the EB IB), when an increase in Egyptian and locally-produced (stylistically and technologically Egyptian) artifacts in southern

Levantine sites suggests an increase in contact between the two areas. Scholars have proposed various explanations for this contact, from trade to military occupation for the extraction of resources, and from small-scale population movements to state-sponsored colonization. What does zooarchaeological evidence reflect about the nature and intensification of this contact between the southern Levant and Egypt?

**Predictions:** Commercial contact between the southern Levant and Egypt would require the use of a reliable source of transport of people and goods. We would then expect to see an increase in the use of donkeys for transport during the Early Bronze IB when this intensive trade is said to have taken place. If animals or their products were commodities for export, we would find evidence for specialized or increased production of certain commodities such as wool, or selection of particular age groups or species for export.

If the EB IB contact between Egypt and the southern Levant were one of colonial presence, we might expect to find zooarchaeological evidence for provisioning (certain meat cuts or ages) or for tribute (rare, wild, or young animals). A colonial presence presumes a spatial separation between the Egyptians and the local Canaanites. These two populations living near each other would recognize differences between themselves. These differences might be expressed in different culinary preferences, such as selection of different species, ages, or parts.

# Chapter 2

## The Chalcolithic - Early Bronze I Transition in the southern Levant: Zooarchaeological Applications to Social Change

The previous chapter broadly defined the characteristics of the Chalcolithic and the Early Bronze I in the southern Levant. It also presented three research themes that this study will approach through the use of zooarchaeological data. The first section of this chapter (section 2.1) reviews past zooarchaeological analyses from Chalcolithic and Early Bronze Age sites. Specific attention is given to the few inter-period studies that compare the Chalcolithic with the Early Bronze Age, as well as those that have addressed differences between the sub-phases of the Early Bronze Age (in particular, the EB IA and IB). It is concluded that past zooarchaeological analyses have not sufficiently addressed some of the important social, political, and economic changes that were occurring during these periods. The second section of this chapter (section 2.2) describes the archaeological and theoretical background to three aspects of the Chalcolithic - Early Bronze I transition that are the focus of this study: the degree of change between the two periods, (including the Chalcolithic collapse), distinctions between the EB IA and EB IB, and the relationship with Egypt from the Chalcolithic through the EB IB. For each of these research themes, areas are defined where zooarchaeological analyses may provide more understanding to these enigmatic periods. This section also elaborates on predicted outcomes (introduced in Chapter 1, section 1.3) of the application of zooarchaeological data to the research questions.

### 2.1 Previous zooarchaeological research on Chalcolithic and Early Bronze I faunal assemblages

This section begins with a review of past zooarchaeological analyses on animal bone assemblages from Chalcolithic and Early Bronze Age sites in the southern Levant. Methods and approaches to dealing with animal bones are shown to change along with changing methodological and theoretical interests. This is followed by a discussion of how zooarchaeological analyses have thus far addressed change between the Chalcolithic and the Early Bronze I, and between the EB IA and EB IB.

### 2.1.1 Zooarchaeology of the Chalcolithic-EB I: An overview of past studies

Detailed faunal analyses from the period in question in the southern Levant are first found in the 1950's in the form of a few articles on the bones from three Chalcolithic sites in the Beersheva area. A general interest in domestication and taxonomy meant that research normally focused on periods earlier than the late 4th millennium. The 1950's and 1960's saw little else in the way of faunal analysis from 4th millennium sites until Ducos' 1968 study of fauna from the Natufian through the Bronze Age. Ducos' work is significant to this study in that he presents faunal data from a number of Chalcolithic sites in a standard format, making it suitable for inter-site comparisons. While his study deals with a significant number of Chalcolithic sites, the only Early Bronze Age site he studies is Tel Gat (Erani). He lumps the Bronze Age together, and has only 2 sites from the entire Bronze Age, only one of which (Erani) is from the Early Bronze Age (the other is Tel Nagila, from the Middle Bronze Age). However, Ducos' work on the Tel Gat (Erani) fauna is important in that it is the first extensive published study of an Early Bronze Age faunal assemblage.

Processual influences of the late 1960's encouraged scholars to approach zooarchaeological analysis from a more scientific angle. A focus on hypothesis testing led to more interest in methodological procedures and saw the emergence of a number of defining works that have since become widely-used standards in Near Eastern zooarchaeological analyses. Among these are Von den Driesch's guide to measurements (Driesch 1976), Payne's sheep/goat mandibular tooth eruption stages (Payne 1973), and Boessneck's distinction between sheep and goat bones

(Boessneck 1969). The acceptance of these works as standards for measurements, aging, and distinction of sheep and goat has facilitated comparisons between assemblages. The processual influence also sparked an increased interest in taphonomic processes, the natural and cultural processes to which artifacts are subjected prior to excavation. Taphonomy became important with the recognition that what we find in the archaeological record is not a direct reflection of human behavior (Lyman 1992:26). It is, rather, a representation of many processes, both cultural and natural, occurring between the time the animal lived and the time of excavation by the archaeologist. To make educated interpretations of animal bone finds, we must consider these taphonomic processes that contribute to our perception of past human behaviors. The 1960's and 1970's, therefore, saw taphonomic issues considered seriously for the first time in the context of zooarchaeology.

The post-processual movement of the early 1980's was largely a reaction to the strict materialism of processual archaeology. The processual approach focused on human subsistence and settlement as part of wider processes, largely ignoring the role of individuals, ideology, and symbolism in the formation of the archaeological record. The post-processual approach emphasized *meaning* behind artifacts and emphasized the significance of the people behind the material elements that we find. People of the past created, used, and manipulated these elements, and therefore their behaviors and beliefs are imperative to the interpretation of archaeological materials. Where the processual school of archaeology saw societies as homogeneous and discrete entities that required an impetus from the outside (such as environmental change) to cause social change, the post-processual critique recognized variability and competition within societies, and saw that social change is possible from within. Internal change is brought about by competition for power between different groups, such as households, kin groups, villages, and individuals. A clear explanation of this model is provided by Stein (1998:6):

> "Instead of viewing chiefdoms and states as well-bounded, homogeneous adaptive systems with clearly defined structures, the focus on power relationships views these polities as "fuzzy" networks with poorly defined and contingent boundaries formed through differential and constantly shifting patterns of cooperation and competition among emergent elites and other groups. In this conflict-based model of society, the key research goals are (a) to identify the main social groups and (b) to define cross-cultural regularities in the organization of competitive social interaction and in the resulting power relationships among these groups."

The search for the individual and smaller groups is motivated by a rejection of the idea that societies are discrete and homogenous wholes. Inspired by this new approach, zooarchaeologists began pursuing new approaches to faunal analysis. More recent studies involve analysis of butchery patterns, body part representation, and the study of non-faunal remains related to animal exploitation, such as figurines and artifacts associated with the processing of animal products (churns, loom weights). The most recent published approaches in zooarchaeological analysis in the southern Levant have involved some use of spatial, temporal and non-conventional laboratory analyses of archaeological bone remains in an attempt to identify activities taking place on a village, household, or individual level. These approaches aim not at defining broad patterns in behavior, but at finding distinctions that can be attributed to some of these more specific issues, such as trade, gender, religion, ethnicity, and culture change, particularly among early complex societies (Crabtree 1990, 1991; Gummerman 1997).

#### 2.1.1.1 Spatial analysis

Spatial analysis is one means by which to identify social, ideological, political, and economic variations within a society. Such factors as small sample size and taphonomic effects can hinder our ability to detect variations through spatial analysis. However, the use of spatial analysis might be the key to identifying those social institutions (villages, households, or even individuals) that provided the variability and competition for power within which social change occurs.

Liora Kolska Horwitz undertook some of the earliest small-scale spatial analyses of animal bones from archaeological sites from the period in question in the southern Levant. Her study of the Chalcolithic Horvat Hor fauna is an example of a manageable collection from which some basic conclusions can be drawn regarding Chalcolithic cave occupation (Horwitz 1990). Although she noted no difference in the number of bones in pits and on the cave floor, or in the distribution of sheep and goat remains, she did notice a difference in sheep/goat body part representation on the floor and in the pits: a higher number of trunk bones were found in the pits, while a higher number of cranial bones were found on the floor. I propose that fewer trunk bones on the floor are a result of trampling and kicking. These bones (mainly vertebrae) are both larger and more fragile than cranial elements (presumably teeth). The trunk elements might not survive in a recognizable state on floors, but would if kicked into pits. On the other hand, teeth would survive better on floors because not only are they hard and could withstand trampling, but they are also smaller and so would get left behind more often in the cleaning of floors. It is of interest to note that Horwitz's Horvat Hor study is one example of a case where MNI can be an appropriate method of analysis. The Horvat Hor assemblage yielded 251 bones, of which 94 were identified. Horwitz determined these to be the meal refuse of a single household (Horwitz 1990:153). Thus, the Horvat Hor assemblage was ideal for a small spatial study of animal use and discard. This study sets an important standard for future faunal studies in that, instead of presenting the bones from the site as a whole, it considers one domestic unit. It's trying to understand the smaller picture, involving the activities of one group or unit, rather than looking at large inter-regional changes.

Horwitz also attempted to delineate differences in the composition of faunal remains in different areas of the Early Bronze Age site of Tel Dalit (Horwitz 1996). The animal bone assemblage from this site is a much larger collection that the Horvat Hor assemblage, allowing for a more detailed spatial analysis. Her intra-site spatial analysis, which dealt with the bones related to various structures within the site, revealed no notable differences in spatial distribution of bones. However, she did note that some areas, such as alleyways, seemed to serve as the rubbish disposal areas of the structures nearby.

Caroline Grigson looked at spatial distribution of bones by area at the Chalcolithic site of Grar (Grigson 1995a). She found statistically significant differences in the relative proportion of domestic ungulate bones in two of the five areas (Grigson 1995a, Table 10.23). This difference reflected a much smaller proportion of pig bones in two of the areas, as well as a smaller proportion of cattle in one area. She also compared the animal bones with the general finds in each area and concluded that the animal bones showed no specific distribution, but reflected general scatter of refuse across the site.

These small-scale studies indicate that spatial analyses are possible, and informative, given a manageable assemblage and explicit contextual information. Spatial analyses are imperative to understanding social processes that take place within a settlement. Differentiation would be expected if households practiced some type specialized activity, or alternative economic strategy, or if members of these households wanted to express some sort of special ethnic, wealth, or religious status. In cases where uniform results were found, the results do not necessarily imply that spatial analysis was ineffective. They might imply a lack of differentiation, or differentiation on such a fine level that it is not apparent through spatial analysis. Unfortunately, the larger the settlement, the longer the occupation, and the more complicated the stratigraphy, the more difficult spatial analysis can become. As far as I am aware, no large-scale spatial analyses have been attempted on animal bones from Chalcolithic or Early Bronze I sites in the southern Levant.

#### 2.1.1.2 Temporal change

More common than spatial analyses have been studies that compare assemblages from two or more periods. Understanding temporal changes in subsistence behavior is one of the ways we can begin to understand what lies behind social changes occurring over a period of time. A convincing temporal study requires a large quantity of bones over many phases of occupation. There are a number of hindrances for temporal studies, not the least of which is the difficulty in defining the temporal relationship of archaeological deposits. Bones are often in secondary disposal contexts resulting from butchery, distribution, cooking (not necessarily in that order), discard, kicking, transport by dogs, and any other pre- and post-depositional taphonomic processes. Also, bones are often found in pits, which might be intrusive deposits, or might represent a later filling of an earlier pit (conversion into a rubbish pit— i.e. something other than the primary use of the pit). Finally, bones cannot be dated through relative stylistic analysis in the way that such materials as ceramics and chipped stone can. Understanding their context thus relies largely upon related artifacts. All these factors make it difficult to decide just how to divide an assemblage temporally for analysis. For example, we can lump the entire Early Bronze Age together (as many past studies have done), or we can separate it into EB I, EB II, and so on. On a higher level, we can further cleave the EB I into EB IA and EB IB. As analysis involves smaller and smaller sub-phase distinctions, the sample sizes become smaller and smaller. Presumably, there is a point at which the sample sizes become too small and thus obscure the results. Conversely, lumping phases into too large a sample size would also obscure any finer distinctions. Therefore, one of the main problems in temporal analysis is determining at what level to undertake temporal distinctions. There is likely no definite answer to this, as each assemblage is unique. The few temporal studies that have been attempted on Chalcolithic and Early Bronze Age assemblages from the southern Levant are discussed in the following sections.

### 2.1.2 Chalcolithic zooarchaeological analyses

The majority of the work detailing Chalcolithic animal economy of the northern Negev has been undertaken by Caroline Grigson (1987, 1988, 1995a, 1995b). Her research has contributed especially to understanding the significance of pigs in ancient economy, the use of cattle for traction, the role of equids in the Chalcolithic, and the nature of secondary products exploitation in the Chalcolithic, especially regarding sheep/goat milking.

From her analysis of ancient subsistence at Grar, a Chalcolithic site in the northern Negev, Grigson concluded that the economy at Grar involved sedentary farmers practicing mixed agriculture (Grigson 1995a:415). Sheep/goat, cattle, and pigs provided meat, and a majority of adult sheep/goat indicates that sheep/goat also provided secondary products, especially wool/hair. While she speculates on the use of other secondary products, such as milking of sheep/goat and cattle, and the use of cattle for traction, she remains cautious about drawing too many conclusions based on the given data. By surveying the presence of pigs at Chalcolithic sites, Grigson found a correlation between the presence of pigs and the amount of rainfall an area receives. Pigs are present at Chalcolithic sites in regions that today receive over 250 mm of rainfall annually, and are absent from sites that receive less than 200 mm of rainfall (Levy et al. 1991). While environment may be a factor in pig-keeping, Grigson and others stress that social or ideological factors may also play a role in the use of pigs (Hesse 1990).

Based on her research, Grigson proposes a spectrum of activity (Grigson 1995b:264), in which she describes two possible strategies of animal management during the Chalcolithic in the northern Negev region (Grigson 1987). One involves sedentary groups raising pigs, sheep/goat, and cattle (based on the assumption that pigs imply a certain degree of sedentism). The other involves seasonal or partial transhumance at sites situated below the present 250 mm annual rainfall isohyet (the ancient 300 mm isohyet). These partially transhumant groups might have placed more importance on secondary products as a result of their separation from the agricultural component of society (Grigson 1989a). However, Grigson points out that the "sedentary" groups might have engaged in some movement of sheep/goat as well, so there is no reason to believe they engaged any less in secondary products exploitation (Grigson 1987). Grigson's work on Chalcolithic faunal assemblages is particularly useful in light of the thoroughness and caution that she takes in her work, always accounting for the potentially biasing effects of taphonomic factors and providing statistical support for many of her findings.

An intriguing focus of many Chalcolithic subsistence studies is the question of the origins, use, and intensification of secondary products. The concept of a secondary products "revolution", introduced by Andrew Sherratt (Sherratt 1981, 1983), proposed the advent in the 4th millennium BCE of a broader use of domestic animals, for milk, wool, labor, and other products that can be taken from them while they are still alive. The "revolutionary" aspect of the secondary products revolution concept is debated, as the transition to the use of secondary products was likely a gradual process, perhaps spanning two millennia (Chapman 1983). However, the concept of secondary products exploitation brought a new interest to the study of more recent faunal assemblages from the southern Levant that comprise mainly domestic animals. While the advent of secondary products is proposed to have occurred in the 4th millennium southern Levant, their use is thought to have become more intensified or specialized in the Early Bronze Age (Horwitz and Tchernov 1989). This presumably relates to emergent complexity associated with the first walled settlements in the EB II. Grigson proposes that the use of secondary products becomes more important as the interdependence with agriculture is reduced (Grigson 1989a). If the population agglomeration and increased sedentism into the EB II saw the emergence of a specialized herding component that was separated from the agricultural component of society, the increased importance of secondary products would follow. The concept of secondary products usage continues to be a popular topic in Near Eastern zooarchaeological analyses, particularly in the 4th and early 3rd millennia, and is critical to the interpretation of animal bones, ceramics, and art.

Some of the most extensive work on secondary products usage in the Chalcolithic of the southern Levant has been done by Caroline Grigson in her work from Chalcolithic sites such as Grar, Shiqmim and Bir es-Safadi (Grigson 1987, 1988, 1995a, 1995b). Grigson's re-assessment of sex and age of sheep/goat bones at the Chalcolithic site of Bir es-Safadi indicated that males of both sheep and goat were killed young, while more female sheep than goat were kept into adulthood (Grigson 1988). These results suggest different herd management strategies for sheep and goat, presumably focusing on milking of both species and wool production. At Shiqmim, bones identified as coming from sheep outnumbered those from goat by about 3:2, suggesting that wool production was even more of a focus than at Bir es-Safadi (Levy et al. 1991). In his study of Early Bronze Age Yarmouth, Davis (1988) also discussed the significance of secondary products. However, he approaches the topic with much caution. He presents the sheep/goat age data saying that a "considerable proportion were slaughtered as mature adults" (Davis 1988:146), but only says that this *might* be because of secondary products exploitation. Further tentative suggestions for secondary products usage at Yarmouth are found in a proximal phalanx of a cow with exostosis on the proximal articulation. Davis admits that more of these types of pathologies must be found before this can be said to be due to strain from pulling heavy loads or ploughs.

### 2.1.3 Early Bronze I zooarchaeological analyses

The animal bone assemblages from many of the Early Bronze I sites analyzed to date are often very small, sometimes fewer than 100 identified bones. Additionally, past zooarchaeological analyses do not consistently distinguish between phases or sub-phases of the Early Bronze Age; instead, they lump together the bones from the whole period. Given these drawbacks, it is not surprising that very few studies attempt inter-phase comparisons within Early Bronze Age bone assemblages. This section reviews some of the more substantial temporal studies that have been attempted using zooarchaeological data from Early Bronze Age sites in the Levant.

In an article dealing with the animal bones from Tel Dalit, Liora Kolska Horwitz (1996) undertook a temporal analysis by looking at species present, body part breakdown, and age profiles for the various phases of the Early Bronze Age. She found that the animal economy did not change during the Early Bronze Age, in spite of noted changes in the settlement. She contrasts this with the situation in the Early Bronze Age at Tel Halif, where Zeder (1990) found differences in the age profiles and relative numbers of species in the different phases of the Early Bronze Age. Horwitz attributes these contrasting results as possibly having something to do with site location. Tel Dalit is in a rich Mediterranean environment, while Tel Halif is on the desert edge, a more fragile environment that would perhaps be more sensitive to environmental or cultural shifts. It is worth mentioning that Davis (Davis 1988:145) attempted a limited temporal comparison of the three different Early Bronze Age phases at Yarmouth, but noted no differences between them.

In their article entitled "Animal Exploitation in the Early Bronze Age of the Southern Levant: An Overview", Horwitz and Tchernov (1989) stress the important role of the subsistence economy in forming and maintaining complex societies. Among their focal questions is difference between Chalcolithic and the Early Bronze Age animal exploitation, and distinctions within different phases of the Early Bronze Age. The latter is relevant in this section, while the former will be discussed in section 2.1.4. Horwitz and Tchernov begin by making the point that, except for two sites (Arad and Tel Yarmouth), no large Early Bronze Age animal bone assemblages have yet been studied (Horwitz and Tchernov 1989:281). They call for more analyses to be undertaken on larger assemblages from distinct phases of the Early Bronze Age (phases that are normally pooled, hindering any inter-phase comparisons), and lament the fact that small sample sizes and lack of inter-phase distinction limits their present study to certain, perhaps less informative, methods of analysis. However, they manage to come up with some interesting observations on Early Bronze Age animal exploitation. First, their sample of sites indicates that sheep/goat dominate all assemblages, and in all cases sheep/goat are at least twice as numerous as cattle. Sheep almost always outnumber goat, and up to 80% of sheep/goat herds appear to have been kept to adulthood. Perhaps their most significant claim is that intensive milking began in the Early Bronze Age. This is based largely upon radiographic analysis of the cortical bone mass in sheep/goat metapodials (described in detail in section 3.3.1.3). Where inter-phase differences could be studied, they reveal no differences in the selection or preservation of either sheep/goat or cattle body parts. A geographic gradient is detected, from north to south, in the presence and numbers of both pigs and wild fauna found at sites. These differences they attribute to environmental differences, where pigs and deer prefer wetter areas such as the north, and the desert gazelle travels in smaller herds than the mountain gazelle, perhaps resulting in less availability of gazelle in the south[4]. Horwitz and Tchernov conclude by proposing a fallow herd management system for the walled towns of the EB II. In this system, females and young would be kept near the settlement while males and castrates would be taken away on a seasonal basis for grazing and/or to supply other larger settlements with supplies (presumably wool and meat). They explain (Horwitz and Tchernov 1989:294):

> "...though small sized herds may have been supported within the range of the urban settlements, large herds of caprovines and cattle would not have been a viable feature. In addition the need for pasture due to over-grazing, disturbance of the soil by herds and agricultural practices would have necessitated the implementation of a fallow herd management system."

Unfortunately, the current data from Early Bronze Age sites cannot be used to sufficiently substantiate this model. Distinctions are needed between assemblages from the small, ephemeral sites of the EB IA, the population agglomeration and increased sedentism of the EB IB, the "urban" areas of the EB II and III, and the less integrated "collapse" phase of the EB IV/MB I. In sum, Horwitz and Tchernov's overview provides a thorough analysis of the available material for the Early Bronze

[4] Even in light of slightly wetter conditions suggested to have occurred in the early part of the Early Bronze Age (Rosen 1989), Horwitz and Tchernov attribute the north-south cline in pigs, cattle, and deer as indicating less than favorable conditions in the south during the Early Bronze Age. While they admit that conditions could have indeed been more favorable at this time, there was still a difference between the environmental potential seen from the north and the south (Horwitz and Tchernov 1989:289).

Age. However, the problem of inter-phase distinction still leaves much to be answered regarding potential changes in animal exploitation during the different phases of this long period. Below is an example of one site in which clear inter-phase characteristics have been recognized, encouraging the search for more assemblages in which these types of distinctions can be made.

Melinda Zeder undertook analysis on a large body of zooarchaeological data from Early Bronze III through Iron Age levels at Tell Halif in an attempt to understand how changing site function and political shifts impact animal exploitation over time (Zeder 1990). While the majority of the Early Bronze Age material came from EB III deposits, Zeder found some intriguing differences between the EB III and a small amount of earlier material from the EB I. Specifically, she found that the EB I faunal remains indicate a broader resource base including larger numbers of equids, pigs, wild animals, and birds, all of which presumably supplemented the normal staples of sheep/goat and cattle. The wider diversity seen in the EB I drops off in the EB III, when sheep/goat comprise 90% of the assemblage. Equids and pigs nearly disappear in the EB III, when the settlement structure has changed from a non-nucleated settlement to a fortified town. Zeder (1990:28-29) interprets her Early Bronze Age results of a narrower resource base, a focus on caprids, and a focus on more restricted age groups in the EB III as reflecting:

> "decreased contact with herds and the procurement of herd products from a more indirect source... in concordance with models that postulate increasing dissociation of the pastoral portion of the economy from settled life, and a corresponding increased importance of pastoral specialists during the Early Bronze Age."

The apparent distinctions between EB I and EB III animal exploitation are encouraging for the present study. While her results are based on a small sample size in the EB I, Zeder's overall findings from the Early Bronze through Iron Age deposits indicate that the changing nature of animal exploitation is a useful means with which to study changing site function over time.

### 2.1.4 The Chalcolithic - Early Bronze I transition

Because of the significant change in settlement patterns in the Early Bronze I, there are very few sites with both Chalcolithic and Early Bronze I deposits. This, together with the confounding nature of this transition, has resulted in the fact that very few zooarchaeological studies attempt comparisons between the Chalcolithic and the Early Bronze Age. This section reviews what we do know about that nature of this transition in light of zooarchaeological evidence.

Animal husbandry in both the Chalcolithic and the Early Bronze Age involved the exploitation of the major Near Eastern domesticates: sheep, goat, cattle, pig, dog and equid. These taxa occur in approximately the same proportions at most sites, with pigs being a notable exception to this pattern[5]. However, in spite of the relative uniformity in species frequencies, there are some noted differences between the two periods. In the first inclusive article about Early Bronze Age animal husbandry in the southern Levant, Horwitz and Tchernov (Horwitz and Tchernov 1989) suggest a number of changes in the Early Bronze Age animal economy. They found that the species and relative frequencies are similar for Chalcolithic and Early Bronze Age sites. However, they noted that there seems to be more of an emphasis on sheep in Early Bronze Age sites in all areas but the Sinai. They also tentatively suggest a slightly higher survival of adult sheep and goat and more females in the Early Bronze Age. These results might indicate an intensification of secondary products exploitation into the Early Bronze Age.

It is generally agreed that secondary products were exploited in both the Chalcolithic and the Early Bronze Age. Grigson's study of sheep and goat survival patterns at Chalcolithic Bir es-Safadi demonstrates this type of exploitation (Grigson 1988). Her results indicate that female sheep and goat (but more so sheep) lived longer than males, implying selective culling for products other than meat in the Chalcolithic. Evidence for secondary products exploitation is also found in the

[5] Differences in relative proportions of pigs may occur for a number of reasons, from environmental conditions to behavioral and economic explanations (this issue has been addressed at length by various scholars (Grigson 1987, 1995b; Horwitz and Tchernov 1989; Redding 1991; Zeder 1994).

subsequent Early Bronze Age, where Horwitz and Smith's cortical thickness study indicates an increase in milking of sheep and goat (Horwitz and Smith 1990, 1991; Smith and Horwitz 1984). They take these results to suggest that the Early Bronze Age saw the first *intensive* exploitation of milk (Horwitz and Tchernov 1989). Although the advent of secondary products usage can be traced to the Chalcolithic or earlier (Grigson suggests the Neolithic), it is difficult to pinpoint the earliest *intensive* secondary products exploitation. The shortcomings of mortality patterns and bone thickness studies necessitate a re-examination of these conclusions (discussed in Chapter 3: Methods). A lack of overwhelmingly convincing data suggests that the question of intensification of secondary products remains unanswered.

In a comprehensive discussion of Chalcolithic and Early Bronze Age plant and animal husbandry, Caroline Grigson presents a thorough survey of animal bone assemblages from Neolithic through Iron Age sites from the southern Levant (Grigson 1995:260-263, Tables 1 and 2). She uses a similar method to that used by Horwitz and Tchernov (1989), adding pigs to the equation (which had previously included only sheep/goat and cattle in Horwitz and Tchernov's study) and taking data from a larger geographic area. All discussion is based on meat weight calculations (minimum weights taken from Clark and Yi (1983) so that the relative importance of each species to the diet is better understood. Grigson admits that "the only information that is widely available is the number of bones of each species retrieved" (Grigson 1995b:250). Other problems include small assemblage sizes (often fewer than 100 bones) and lack of inter-phase distinction (such as between the EB I and EB II). In spite of these problems, she is able to find some trends in the available data with which to make some observations about the nature of Chalcolithic-Early Bronze I animal husbandry.

Grigson's review finds the same increase in sheep/goat into the Early Bronze Age that Horwitz and Tchernov reported. Looking at the sheep/goat ratio, she also finds an increase in the use of sheep from the Neolithic/Chalcolithic to the Bronze Age. Sheep provide secondary products, making them a component of accumulation of wealth. This increase in sheep might, therefore, indicate "a shift from a subsistence to a market economy, becoming more sophisticated as a response to urbanism" (Grigson 1995b:251). Grigson finds a predominance of cattle, in meat weight terms, in all periods. She finds that pigs, who are scarce in the desert edges, make up 15-20% of the meat from Neolithic and Chalcolithic assemblages, but decline after that, never making a very significant contribution to the diet. She concludes that the Early Bronze Age involved a settled, agricultural lifestyle with marked economic changes from the preceding Chalcolithic period, especially in the desert edge, where environmental degradation might have played a role (Grigson 1995b:251).

### 2.1.5 Directions for future research

The Chalcolithic and Early Bronze Age zooarchaeological studies discussed above demonstrate that zooarchaeological analyses can be extremely variant, depending on the type of site, the state of preservation, the size of the animal bone collection, and the funding available for detailed analysis. Thus, one finds a wide range of analyses, from the simple "bone report", listing relative frequencies of species with very little interpretation, to detailed analyses of large assemblages, discussing survivorship, sex, and butchery, and including measurements and contextual information. While this variation allows for individuality and creativity in zooarchaeological analyses, it can be very detrimental to inter-site comparisons. Unfortunately, few sites dating to the Chalcolithic or the Early Bronze Age in the southern Levant have produced large enough faunal assemblages for detailed inter-assemblage comparisons. In particular, there is little faunal data from sites from all phases of the Early Bronze Age. Grigson's (1995b:260-262, Table 1) compilation of information from sites from the Neolithic through the Iron Age demonstrates the relative paltriness of the Early Bronze Age assemblages compared to other periods. Specifically, Grigson's tables indicate a paucity of faunal analyses from Early Bronze

IA sites, and a lack of distinction between the various phases of the Early Bronze Age in general.

Zooarchaeological research to date has provided an overall picture of Chalcolithic and Early Bronze Age subsistence economy. Certain key issues have become the focus of research on these periods. Examples of these include the use and intensification of secondary products in both periods, the role of pigs in relation to the environment and ideology, the use of cattle for draught (specifically in the Chalcolithic), and the increased use of sheep in the Early Bronze Age. However, there is room for more in-depth analyses regarding critical aspects of change in this transitional period. To understand ancient economic changes, we need more inter-period comparisons and more focus on intra-site variation. In order to understand the variations within a society that provide for the development of social complexity, we need to look not at broad differences, but at finer ones on an *intra*-societal level.

## 2.2 Background to social change in the Chalcolithic - Early Bronze I

This section describes three areas in which social, political, and economic changes during the Chalcolithic-Early Bronze I are said to have occurred. For each of these three research themes, the archaeological evidence is presented, followed by a description of the prevailing theories explaining the changes that are said to have occurred. This is followed, in each case, by a discussion of how zooarchaeological analysis might help our understanding of change in the Chalcolithic-Early Bronze I. Predicted outcomes for the application of zooarchaeological data to the prevailing theories are also detailed.

### 2.2.1 Continuity and change between the Chalcolithic and the Early Bronze IA

#### 2.2.1.1 Archaeological evidence

While scholars debate the degree of change between the Chalcolithic and the Early Bronze Age, most agree that elements of both continuity and change can be detected between the two periods. The Chalcolithic (ca. 4500-3700 BCE) shows a high degree of uniformity throughout Israel, but with regional variations due to environment and raw materials (Gonen 1992). The region of interest for this study during the Chalcolithic is characterized by the emergence of large village communities that show specialization in ivory carving, copper metallurgy, an abundance of well-crafted cultic and prestige objects, flood-water irrigation of agriculture, the appearance of cult centers, and possible intensive exploitation of secondary products of animals (Levy 1992b; Stager 1992). However, sometime around 3700-3500 BCE the majority of these characteristic elements of Chalcolithic life came to an end, indicating some kind of collapse. A society can be said to have collapsed when it "displays a rapid, significant loss of an established level of socio-political complexity" (Tainter 1988:4). Indeed, the elements that identified the Chalcolithic with an established level of social complexity (for example, specialization in ivory carving, copper metallurgy, and craft production) disappear in the ensuing Early Bronze IA.

Evidence for the collapse of the Chalcolithic is found in the apparent return to small village life, in which some Chalcolithic traditions continue, but overall there is no more evidence for elites, certain pottery types, and the corpus of "prestige"-type objects so prevalent in the Beersheva Chalcolithic. The Early Bronze IA also provides little evidence for such hallmark objects of the Chalcolithic as copper prestige items, ivory objects, painted ossuaries, and figurines and ceramics associated with milking. Instead, utilitarian copper and cruder, less specialized ceramic production (Levy et al. 1997) characterize the EB IA. Fewer, smaller, and more ephemeral sites in the EB IA stand in marked contrast to the well-established settlement of the preceding Chalcolithic (Gophna and Portugali 1988). A significant shift in architectural traditions, from rectilinear in the Chalcolithic to curvilinear in the EB IA, reinforces the degree of change between the two periods, suggesting less organization and social differentiation. The corpus of evidence points to a lesser degree of social complexity and a looser social organization in the Early Bronze IA than in the Chalcolithic (Braun 1996:10-18).

While the gap between the Chalcolithic and the Early Bronze IA in the north appears to have been profound, in the south (especially in the southern Shephelah and southern coastal plain) both typological and technological continuities between the two periods have been observed (Gophna 1995:272). Eliot Braun (1998:14-18) provides a comprehensive review of archaeological evidence for continuity and change between the Chalcolithic and the EB IA (what he terms "early EB I"). A sharp contrast is seen between the rectilinear architecture of the Chalcolithic and the abrupt change to curvilinear architecture in the EB IA[6]. The chipped stone assemblage of the Chalcolithic includes adzes, axes, drills, and sickle blades. These tool types disappear in the EB IA, and continuity is only found in the tabular scraper, present in both periods. The EB IA sees a decrease both in the diversity of tool types and the quality of production (Braun 1998:21). The exception to this decline is the Canaanean blade, which becomes ubiquitous in the EB IA. Copper tools of the EB IA provide a different picture. While the copper "prestige" objects such as maceheads, standards, and crowns, found in abundance in the Chalcolithic Nahal Mishmar hoard, are no longer found in the EB IA, utilitarian copper objects become more common. These include adzes, axes, and awls, leading some to suggest that metal replaced stone as the medium for the tool repertoire of the EB IA (Rosen 1984), as well as explaining the disappearance of these forms in the chipped stone assemblages of the EB IA.

Excavations at the EB IA site of Taur Ikhbeineh in the Gaza region found a high frequency of retouched bladelets and well manufactured basalt bowls of a type that show links with the preceding Chalcolithic (Oren and Yekutieli 1992). Continuity between the Chalcolithic and the EB I is also seen in certain pottery types and manufacture techniques, where some EB IA examples indicate maintenance of Chalcolithic ceramic traditions. However, many pottery types from the

[6] Rectilinear forms appear once again in the EB IB.

Chalcolithic become much less common in the EB IA (these include v-shaped bowls, goblets, churns, and ossuaries). While some new forms appear in the EB IA (wavy-edged ledge handles, bag-shaped vessels, pithoi), the disappearance of v-shaped and other thin ware vessels indicates a decline in craftsmanship in the EB IA (Braun 1998:20). Braun's review of burial traditions (method and location of burial) shows both continuity and change, largely due to a broad diversity in burial customs in both periods. Finally, in reviewing the extensive corpus of Chalcolithic artistic traditions, and the smaller body of artistic work from the EB IA, Braun concludes that artistic production was both quantitatively and qualitatively much lower in the EB IA (Braun 1998:27). It is interesting to note that the majority of the few art works from the EB IA constitutes draft animal and laden animal figurines.

Chalcolithic site distribution seems to reflect a preference for open, level areas and more marginal regions. This choice of terrain, avoiding hilly areas, might reflect the economic activities of the Chalcolithic populations, who preferred marginal areas for herding and seasonal movements (Gonen 1992:47). The Early Bronze I sees a population reorganization that involves a move out of the marginal areas an into the highlands, the Shephelah and Coastal Plain where the Mediterranean climate prevailed. In the northern Negev, the collapse was nearly complete; however, in other areas, there is some continuity into the EB I, such as continued occupation, in one form or another, at such sites as Beth Shean, Tell-esh Shuneh, Neve Ur, and Abu Hamid (Joffe 1993). The transition from the Chalcolithic to the Early Bronze I is marked by a demographic shift: overall, 75% of Chalcolithic sites end by the EB I, while 25% continue. 71% of the EB I sites are new, while 21% of EB I sites are associated with an earlier Chalcolithic occupation. These numbers show that there was some continuity of occupation; however, the picture is different across the country. For example, in the northern Negev, sites dropped from 35 in the Chalcolithic to just eight in the EB I, none of which can be attributed to the EB IA (Joffe 1993:41), while in the north there is more continued occupation into the EB I.

During the Chalcolithic, there is evidence for exchange of raw materials over a wide area: basalt from the north, shells from the Nile and the Red Sea, turquoise from the Sinai, copper from Timna, arsenical copper from Anatolia, Iran, or the Caucasian mountains, elephant ivory from Africa or Syria, hippopotamus ivory from Egypt (or nearer) (Gonen 1992:62). Many of these materials were expertly crafted into objects, both practical and symbolic, indicating the existence of specialized craftspeople in the Chalcolithic. The largely uniform nature of Chalcolithic ceramics and material culture points to frequent and well-established inter-regional contact and exchange. Evidence for exchange on a wider scale is found in small numbers of Egyptian artifacts, such as stone vessels, palettes, and maceheads at southern Levantine Chalcolithic sites (Joffe 1993:57). Southern Levantine technologies and motifs are also found in Lower Egyptian sites (Buto/Ma'adi) during this time. Archaeological evidence for, and theories regarding the nature of the contact between Egypt and the Southern Levant from the Chalcolithic through the Early Bronze IB are discussed in detail in Section 2.2.3.

During the EB IA, ceramic styles are more varied and cruder, indicating both a lower degree of inter-regional contact and specialization. While this decreasing quality and increasing regional variability of EB IA pottery may suggest diminished exchange relationships, paradoxically long-distance exchanges seem to persist and even intensify. Evidence for exchange on an international scale is found in a silver bowl from Tell el-Far'ah North and gold and silver beads from tombs, indicating contacts as far away as Asia Minor (Ben Tor 1992:90). More significant, however, is the relationship with Egypt during this time. The EB IA sees increasing evidence for contacts between Lower Egypt and southern Canaan. Egyptian ceramics, Egyptian-style pottery imitations, and Egyptian-style flints found at the more southern sites in Canaan such as En Besor Site H provide evidence for an increase in interaction between the two areas. Ceramic evidence from Taur Ikhbeineh in the Gaza region shows during the EB IA a mix of local Canaanite pottery, imported Egyptian pottery, and locally-made Egyptian pottery at the site (Oren and Yekutieli 1992).

The authors take this as evidence for the co-existence of Lower Egyptian and Canaanite pottery workshops at or near the site. This also suggests that Egyptians and Canaanites were living and working in close proximity during the EB IA at Taur Ikhbeineh.

Southern Levantine elements such as ceramics and possibly metalworking at Ma'adi suggest that the same was true of settlement in Lower Egypt, where "small, but well organized communities of merchants and craftsmen living alongside local inhabitants in the Nile delta and southern Canaan respectively" (Oren and Yekutieli 1992:382). Southern Levantine and Lower Egyptian sites during this time show some similarities in ceramic styles, chipped stone (Stager 1992), and architectural styles (Bard 1994), suggesting some kind of contact between the two areas (these are discussed in further detail in Section 2.2.3*)*. Further evidence from Egypt includes finds of southern Levantine raw materials such as copper, and also southern Levantine ceramic storage vessels found in Egyptian tombs during the EB IA (Rizkana and Seeher 1989:78). Evidence for contact between Lower Egypt and the southern Levant during the EB IA extends from southern Canaan to Egypt. As will be discussed, the role of the domesticated donkey was probably very significant in this relationship. While it was more intensified than during the Chalcolithic, this contact was not on nearly the scale it reached during the EB IB. Scholars continue to debate the scale, organization, products for exchange, and motivations behind the exchange throughout the Chalcolithic-EB IB. This is discussed in more detail in Section 2.2.3.

Chalcolithic objects such as those made of ivory, copper, and basalt suggest the presence of specialized craftspeople. In addition, the uniformity of Chalcolithic ceramics and other objects indicates regional interaction and craft specialization of ceramic production. Excavations at Bir es-Safadi produced evidence for an ivory workshop and also copper-working. This, together with an absence of sickle blades in the flint assemblage from the same site, might indicate that the inhabitants of the site did not take part in agricultural activities, but specialized in ivory and copper working to exchange for food and other products (Gonen 1992:61-62). Evidence for specialization in the EB I is found in the production at many sites of utilitarian copper objects (adzes, axes, daggers, and awls), basalt objects, and Canaanean blades. While these might not have been full-time specialized activities, they do require some degree of specialized knowledge. Finkelstein and Gophna (1993) hint at horticultural specialization already established in the highlands during the EB IA and was one of the factors leading to the rise of Early Bronze Age complex society. Stager (1992) also sees the emerging importance of horticultural products, especially wine and olive oil, in the EB I.

However, other evidence points to a lower degree of specialization in the EB I than in the Chalcolithic. The small number of "prestige" and artistic objects in the EB IA indicates a decline in the type of craft specialization seen earlier. The variety and regional nature of ceramic styles in the EB I suggests a low degree of craft specialization and limited regional interaction. In addition, the shift to curvilinear architecture in the EB I might indicate less site planning and fewer areas of specialized activities within structures (Joffe 1993:48). These lines of evidence suggest that while there may have been a decline in some craft specialization in the EB IA, other areas of the EB IA economy, in particular horticultural production, may have experienced increased specialization.

The archaeological evidence detailed above, when considered as a whole, indicates clear material cultural differences between the Chalcolithic and the EB IA. However, when looked at more closely (for example, when looking at the manufacture of ceramics in the south), the boundary becomes less clear, particularly in certain regions of the southern Levant. For the Chalcolithic way of life to come to an end after 1000 years required a significant upset in the established system. However, the elements of continuity into the EB IA suggest that this transformation was not completely upsetting to the Chalcolithic populations. The changes we see into the EB IA are adaptive responses to the new situation, regardless of the stimulus. After nearly a millennium passed showing few (or so far undetected) social, political, or economic changes in the lifestyle of the Chalcolithic peoples of the southern Levant, the numerous changes noted in the transformation to the EB IA certainly affected every aspect of their lives, including their way of thinking. While evidence for such is difficult to deduce, the observed material culture changes are certainly accompanied by ideological changes that would factor significantly in the way things were done during the EB IA. The following theories might shed some light on the impetus for change, which was, in all likelihood, not a singular event, but a complex combination of events, processes, and choices.

2.2.1.2 Theoretical background to the Chalcolithic-EB I transition

This section discusses and critiques various proponents of continuity and change in the Chalcolithic-Early Bronze I transition. This is followed by a discussion of theories regarding the Chalcolithic collapse (section 2.2.1.3). From this background, certain elements are selected that can be tested with zooarchaeological data (section 2.2.1.4).

Alexander Joffe proposes a mode of social organization for the Early Bronze I showing a high level of continuity from the preceding Chalcolithic period, but with a change in the organization of power between the two periods (Joffe 1993:2). He explains:

> "The Chalcolithic saw politico-religious elites in control and reinforcing authority through control over long-range procurement of raw materials and craft production, especially symbolic items. In the Early Bronze Age agrarian elites controlled craft production and distribution of agricultural products for intra- and inter-societal trade. These elites were eventually located in 'urban' sites."

Joffe suggests that, while production in the Chalcolithic and Early Bronze I remains household-based (as in the Chalcolithic), the nature of power relations shifted. In the Chalcolithic, power involved control over "prestige" or symbolic goods, whereas in the Early Bronze Age, partly due to the relationship with Egypt, it involved control over agricultural commodities and trade. This proposed change in the organization of power finds archaeological support in the decrease in "prestige" objects and predominance of practical objects in the Early Bronze Age in the southern Levant. Further support is found in wine residues and olive stones in Palestinian pottery from tomb U-J in Abydos, Egypt, indicating trade in agricultural commodities such as wine and olive oil (Dreyer 1990; McGovern et al. 1997) during this period.

A survey of various lines of archaeological evidence from a compilation of Chalcolithic and Early Bronze Age southern Levantine sites led J.W. Hanbury-Tenison to conclude that change occurred, but as a gradual, indigenous development with a significant break between the two periods(Hanbury-Tenison 1986:251). He suggests that change between the Chalcolithic and Early Bronze Age involved economic privatization in the EB I (Hanbury-Tenison 1986:102). He claims that economic strategies in the Early Bronze Age focus more on arable farming than on herding, suggesting that groups settled down when they saw the value of such resources as land and water control. He proposes that economic privatization and differential access to resources resulted in a move toward hierarchy, accounting for the differences in material culture between the two periods. Evidence for proposed privatization is found in the wider distribution of objects of value in the Early Bronze Age, as opposed to the Chalcolithic, which saw numerous prestige objects in a much narrower distribution. An example of this in the Nahal Mishmar hoard, a Late Chalcolithic assemblage of prestige copper objects whose distribution in one spot suggests corporate ownership (by a temple, for example). This is opposed to the more wide-spread and utilitarian nature of copper objects in the EB I. I suggest that, while change between the two periods no doubt involved some type of economic shift, the limited distribution of prestige objects in the Chalcolithic might, alternatively, indicate private property, not corporate ownership. The singular discovery of the Nahal Mishmar hoard is, likewise, not enough evidence for corporate ownership in the Chalcolithic.

Thomas Levy's survey and excavation of Chalcolithic settlements in the Beersheva area helped define much of what we know about Chalcolithic settlement and society. Of the Chalcolithic-Early Bronze Age transition, Levy proposes that "the differences between local Chalcolithic and Early Bronze Age social organization seem minimal – a relationship which needs to be systematically investigated" (Levy 1995:226). However, he also suggests that the Chalcolithic saw a level of social complexity equated with the emergence of chiefdoms in this region, while the following Early Bronze I period is thought of as characterized by a more agro-pastoral lifestyle with diminished settlement size and less elaborate craft production than in the preceding Chalcolithic period.

Levy's concept of Chalcolithic social organization portrays a system based on the promotion and maintenance of Chalcolithic elites. The system was maintained by three predominant factors: resource competition, risk management, and gift giving (Levy 1995:238). Resource competition involves population increase and intensified land use together encouraging the growth of leadership in the region through the need to defend valuable resources such as land and produce (Levy 1995:238). Related to resource competition is "risk management", the means by which people monitor or control their activities so as to prevent damage from recurrent environmental downturns. The Beersheva area, located on the desert edge, is a marginal area subject to episodic drought. In light of a relatively higher risk of instability in the desert margin, the Chalcolithic populations in the Beersheva area must have had a highly efficient (or controlled) system of risk management to have flourished in the area for so many centuries. This system may have been formalized by the establishment of regulating institutions such as cult centers, shrines, palace organizations and formal cemeteries (Levy 1995:239). Levy proposes that the Chalcolithic sanctuary of Gilat, situated at the interface of the Northern Negev and the Negev Coastal Plain, might have served as just such an institution. By regulating access to grazing lands through a "symbolism of place" (Levy 1995:239), Gilat thereby helped prohibit the potentially disastrous diminution of pasture in the region[7]. Levy suggests that this type of risk management of land resources might have helped promote his hypothesized Chalcolithic elites.

While risk management and resource competition served to strengthen Chalcolithic elites, a system of "gift giving" served to maintain them. Levy defines gift giving as a system whereby "the maximum number of relationships can be created and maintained by placing participants in a situation of debt" (Levy 1995:240). By restricting access to certain products or methods of production, an uneven flow of materials is created which forms the basis of a debt-based society in which one individual, group, or class (the "elite") holds the reins. Levy describes the access to and production of copper objects as the predominant example of gift giving during the Chalcolithic. Copper smelting in the Beersheva area took place far from the mines,
thereby limiting access to both the resource and the knowledge of pyrotechnology to a few individuals or groups. This limited knowledge thus increased the value of the final product. Whoever maintained control of access to copper, copper smelting, and/or copper "prestige" items was able to place others in a position of debt. Copper production therefore strengthened the position of the elites in Chalcolithic society. Power can be reinforced by other means as well. For example, elites can also use environmental fluctuation to reinforce their power. In times of environmental instability, elites with stored reserves could assist those people without food or supplies. The elites would therefore reinforce and increase their power by placing people in a position of debt to them.

Different herd management strategies have been proposed for the Chalcolithic communities of the northern Negev. Gilead (1988) proposes integrated agriculture and animal keeping in a system of mixed farming. This system would involve some

[7] Excavations at Gilat produced numerous anthropomorphic and zoomorphic figurines which are thought to be associated with fertility, milking, and herding. These objects are found in uncommonly high numbers, indicating that Gilat served some religious, cultic, or otherwise extraordinary purpose.

movement of animals, not usually more than 15 km between villages. Levy (1992), on the other hand, proposes a system of village-based transhumance, involving seasonal movements of flocks to areas of better pasture. This system does not involve pigs, as they are thought unsuitable for partial transhumance. This system also implies a lower level of integration of farming and animal husbandry, with specialized herding activities occurring for at least part of the year.

### 2.2.1.3 Theoretical background to the Chalcolithic collapse

Inherent to an understanding of the Chalcolithic - Early Bronze Age transition is a review of the prevailing theories of why the complex societies of the Chalcolithic period in southern Palestine came to an end. A number of factors have been suggested to have contributed to the Chalcolithic decline, which spanned two centuries (ca. 3700-3500 BCE). The next three sub-sections discuss three of the popular theories of the Chalcolithic collapse: climatic fluctuation, an "attenuation of structures", and what is referred to as "commercialization", involving increased contact with Egypt (Levy 1995:240-243).

#### 2.2.1.3.1 Climatic fluctuation

While the Chalcolithic populations of the northern Negev had well-established agro-pastoral communities, their farming systems at the edge of a desert may have been more sensitive to environmental fluctuation than less marginal areas. In this way, the Northern Negev area may act as a barometer for climatic, social and economic changes. Changes which might seem slight in a less arid environment would have more notable effects on the populations living in the northern Negev (Grigson 1995:249; Horwitz and Tchernov 1989).

A slightly more humid phase around the Chalcolithic-Early Bronze Age transitional period might have caused changes in the pattern of flooding in the drainages of the Negev (Rosen 1989). This change would have altered the effect of the complex system of flood-water farming which had become a way of life for the inhabitants of the villages of the northern Negev. Shiqmim (the Chalcolithic site used in this study) sits on the bank of one of these drainages, the Nahal Beersheva, and would have been greatly affected by unpredictable flooding or drought, affecting both food production and access to pasture.

A climatic shift may have had touched other areas of Chalcolithic society as well. For example, the proposed debt-based system for the Chalcolithic would require resources to support elites and the production of "prestige" objects. In an environment with unpredictable climatic shifts, the risk involved in maintaining elites would be increased, perhaps making the elements of social complexity too costly. When the cost of social complexity exceeds the benefits, collapse can occur (Tainter 1988:195). An environmental shift is therefore a potential candidate in contributing to the Chalcolithic collapse. However, as is demonstrated below, the evidence for a specific environmental shift that can be attributed to the period around 3500 BCE is not easily found.

While natural environmental fluctuation may well have been a factor that contributed to the Chalcolithic collapse[8], there is little evidence for specific and marked climatic changes occurring at the end of, or any time during, the Chalcolithic. There is a paucity of palaeoclimatic data for the Near East in general during this time (Roberts and Wright 1993), particularly on a regional scale. Goldberg and Rosen (1987) summarize the various lines of palaeoenvironmental evidence from Israel, including information derived from deep-sea cores, lake beds, palynological studies, and faunal analyses in their *Shiqmim I* chapter entitled "Early holocene palaeoenvironments of Israel". In their review, Goldberg and Rosen note an increase in tree pollen and olive between 7400-4500 BP that might correspond with an increase in precipitation. Alluviation patterns of gravel and finer sediments in the area around Shiqmim indicate a phase of wetness during the Chalcolithic in this area,

[8] Man's impact on the natural environment of the southern Levant does not seem to have had a detrimental effect until perhaps the 3rd or the 2nd millennium BC (Miller 1997; Baruch 1990), so we are presuming that any environmental shift involved in the Chalcolithic collapse would have been natural.

which was possibly followed by a drying phase at the end of the Chalcolithic (Goldberg 1987; Goldberg and Rosen 1987). This is supported by deep sea cores which point to increased humidity in the early part of the Holocene in Israel, followed by a period more arid than the present, perhaps around 5000 BP (Goldberg 1987). In sum, Goldberg and Rosen propose a moister phase around 5500 BP, which would account for the heavy alluviation noted at Shiqmim and would correspond (roughly) with the end of the Chalcolithic and the beginning of the EB I. This is supported by Goodfriend's chronostratigraphic study of Negev sediments using land snail shells which indicates "moderately high" rainfall from ca. 6500-5500 BP and 5000-3000 BP, followed by the driest period in the late Holocene (after ca. 3000 BP) (Goodfriend 1987).

A preference of Chalcolithic populations to settle in what appear to have been "marginal" environments might indicate that these marginal regions were wetter during the Chalcolithic. Gilead sees a more favorable climate as support for his argument that regular or seasonal semi-nomadism was *not* a component of the Chalcolithic in the northern Negev (Gilead 1992). He suggests, instead, that a more humid climate helped the larger villages to flourish, enabling permanent occupation by sedentary farmers who might have herded sheep and goat in the vicinity up to 10-15 kilometers from the site. On the other hand, in reviewing Chalcolithic settlement patterns, Gonen (1992:47) finds little support for a moister period. She sees the Chalcolithic settlement in marginal areas as not reflecting a more humid phase that made these areas more "favorable". Rather, the open, arid regions were the preferred environment for a society whose socio-economic organization involved pastoralism and seasonal agriculture.

There is some faunal evidence from the Neolithic that indicates moister conditions at some sites during the Neolithic when compared with later periods (Goldberg and Rosen 1987). The relative numbers of pigs compared to sheep/goat and cattle in some regions seems to decrease steadily from the Chalcolithic onwards (see Grigson 1995:252, Figure 6). It is not known whether this decrease in pig numbers has to do with increasing aridity, societal attitudes towards pigs, or some other factor or combination of factors (Grigson 1995:255). A high proportion (16%) of pigs at Chalcolithic Teleilat Ghassul (Davis 1982), together with evidence for fruit, date, and olive trees suggest that the climate in the Jordan Valley was moister during the Chalcolithic and the Early Bronze Age than later times. Based on zooarchaeological and archaeobotanical data, Grigson (1995:256) suggests that aridity became a problem only later in the Early Bronze Age, particularly on the desert edge, and contributed to the EB IV collapse. As far as animal bones are concerned, the incipience of domestication affects our interpretation of the faunal record in more recent periods; that is, the taxa present at sites may have very little to do with environmental changes. Additionally, faunal evidence varies from site to site and from region to region, emphasizing the regional variation found in the diverse landscape of Israel. What taxa are found and why is not only a product of the environment but also of human actions regarding animals and the use of the surrounding environment.

Data from Chalcolithic alluviation, snail shell carbon isotopes, and faunal data summarized above indicate wetter conditions prevailing in the northern Negev area around 6000 to 7000 years ago (Goldberg 1995:52), followed at some point by a more arid period. On a wider scale palynological data indicate an early Holocene forestation of the Near East, a climate "Optimum" with warm winters and wet summers between about 9000 and 6000 BP (Rossignol-Strick 1997). This forestation occurred by about 9000 BP near the sea and was followed, on a broad scale, by a diminution in forestation by around 6000 BP[9] (Roberts and Wright 1993). Also by about 6000 BP winter temperatures begin to decrease, and the climate becomes more similar to that of today (Rossignol-Strick 1993). While the northern area of the East Mediterranean was drier in 6000 BP than in the present, the southern area was wetter. In between these two areas lies the Levant, whose moisture levels between 6000 BP and the present show no indications of change (Roberts and Wright 1993:Figure 9.17). Additionally, Roberts and Wright see no marked fluctuations in

[9] The timing of this is wide-spread across the Near East, occurring latest in Eastern Turkey and Iran.

pollen levels in the Levant between either 9000 BP and 6000 BP, or between 6000 BP and the present (see Roberts and Wright 1993:Figure 9.13). Thus, while large-scale changes are, indeed, occurring in the greater area of the Near East, the region of the Levant provides very little in the way of detectable changes. The Levant lies between two areas that are each experiencing different palaeoclimatic changes from 9000 BP to the present (drier in the north, wetter in the south). The Levant's location on the interface of these two areas suggests either 1) there were no marked large-scale climatic changes during this period, or 2) any changes that did occur are not detectable or have not yet been detected.

Evidence for more global environmental shifts during this time is found in an ice core from Summit, Greenland, that indicates climatic shifts in the Holocene, including a cold event from 5200 to 6000 years ago (O'Brien et al. 1995). This shift broadly falls within the span of the later part of the Chalcolithic and into the early part of the Early Bronze Age. However, some of these global changes are noted in one Greenland core and not in others, leading the authors to conclude that "as the Holocene progressed, environmental change increasingly occurred on a regional basis" (O'Brien et al. 1995:1963). This warns us that, while global changes can be detected, they do not necessarily reflect the environmental situation in a specific region, such as the southern Levant.

In sum, indications of Holocene climatic shifts can be found on a global scale, across a wide geographic area, and on a more regional level. However, the various lines of evidence do not all point to the same conclusions. Evidence indicates that the Chalcolithic in the Negev was moister than at present, and while it was followed by a more arid phase, the onset of this phase is not yet known. Some suggest a more arid period did not commence until the EB IV (ca. 2200 BCE) (Grigson 1995), in which case it would not be related at all to the Chalcolithic collapse. No detectable environmental change can be attributed specifically to the Chalcolithic-Early Bronze I transition, although global data cited above indicate a cold event attributed to the period around 5600 BP. These data reflect a global scale, while climatic fluctuations certainly also occurred on a regional scale. Fluctuations on a regional scale can be expected in the southern Levant whose varied topography provides diverse micro-environments. The existence of multiple micro-environments perhaps makes it even more difficult to detect and distinguish regional climatic changes. Regional climatic shifts would have affected the people living in those areas, possibly causing them to change their behavior locally or even move elsewhere. The Chalcolithic way of life spanned one thousand years from approximately 4500-3500 BCE, during which time there was certainly at least some small-scale climatic shift. The Chalcolithic preference for settling in "marginal" areas would have made them particularly sensitive to climatic changes. Any shifts that did occur, however, obviously did not cause the Chalcolithic to collapse for 1000 years. If an environmental shift caused the decline of the Chalcolithic, it must have been significant. There is little evidence at present to indicate the occurrence of such a significant shift. While the Chalcolithic collapse likely involved factors other than environmental change, an environmental contribution to the collapse is area that certainly merits further investigation.

On a final note, not only is there a problem with detecting smaller-scale environmental changes, there is also a problem dating them. Not only do we need hard evidence for environmental changes, we also need to be able to date these changes and somehow correlate them with the Chalcolithic and Early Bronze chronology, which is in itself imprecise and continually changing. Thus, we must take the above summarized evidence for environmental shifts as possible factors in the Chalcolithic collapse, even though they cannot be narrowed down to a more specific time. While we cannot pin-point a particular environmental shift to the Chalcolithic-EB I transition, the evidence discussed above broadly indicates that environmental fluctuations did, indeed, occur. While they might not have been significant enough to independently cause the Chalcolithic collapse, they might have been one of many factors that contributed to the collapse.

2.2.1.3.2 The disintegration of the socio-political superstructure of society

Joffe uses the term "attenuation of sociopolitical and related economic structures" (Joffe 1993:37) to refer to what he sees as a collapse in the socio-political superstructure of society in the northern Negev. He explains (Joffe 1993:37):

> "The apparent inability of established elites to respond to change, climatic or otherwise, is seen in the complete and utter disappearance of the symbols that are the hallmarks of the Chalcolithic, the linked politico-religious iconography and its specialized production apparatus. There are no more ivories, copper standards, cornets, decorated ceramic ossuaries, elaborate ceramic figurines, or wall frescoes with fantastic motifs. In EB I there are only simple stone maceheads, ceramic figurines of laden donkeys, fenestrated stands, holemouth jars and v-shaped bowls. The essential *ritual* paraphernalia and domestically produced ceramic forms continued, bespeaking the essential continuity of populations of the two 'periods', while the 'superstructure' of society disappeared along with the fabric of settlement."

Joffe argues that this break-down could have been caused by any alteration in one area of the carefully balanced system. For example, a shift in climate or the balance of power would cause "shock waves" through the society that would have affected the rest of the society. However, it is important to note that a change in one dimension does not always imply a change in others (Arnold 1996:4). Even if this were the case, the theory still does not *explain* the Chalcolithic collapse. It might explain how instability in one area can affect other aspects of society, but it does not define the initial stimulus. Rather than view this as a theory for the Chalcolithic collapse, it is useful to use it as a possible explanation as to why the collapse was so complete in the Beersheva area.

2.2.1.3.3 Commercialization

The commercialization model suggests that contact with Egypt might have contributed to the breakdown of Chalcolithic society. Toward the end of the Chalcolithic, contact between Egypt and the southern Levant can be inferred through such evidence as v-shape bowls at Buto in Egypt (Bard 1994). Periodic contact between Egypt and the southern Levant piqued the Egyptian interest in copper and other resources from the southern Levant, leading to increased interaction between the two areas into the EB IB. Finds from Ma'adi in the Nile Delta recall links to the mid-4$^{th}$ millennium southern Levant, including copper objects and ores, asphalt (presumably from the Dead Sea), and equid bones (Bökönyi 1985; Joffe 1993:37; Rizkana and Seeher 1989). To meet the demand for copper ore, entrepreneurs from the southern Levant exploited copper mines for the Egyptian market (Joffe 1991). The Egyptian "buyers" did not share the ideology surrounding copper "prestige" objects that formed the basis of the Chalcolithic debt-based society. A new focus on raw materials and the production of goods for export would have introduced disrupting factors to the debt-based system (Levy 1995:242) thought to have formed the basis of the Beersheva Chalcolithic socio-political structure. The shift in meaning (metal as a commodity with market, rather than symbolic, value) might have caused a breakdown of the Chalcolithic system that involved elite gift-giving based in symbolism and ideology. The "commercialization" of the southern Levant, then, may have hastened the break-down of the earlier Chalcolithic politico-economic order (Joffe 1993:37) in light of new international opportunities and influences.

#### 2.2.1.4 Zooarchaeological applications to the Chalcolithic-EB I transition

##### 2.2.1.4.1 Zooarchaeological applications to theories of change between the Chalcolithic and the Early Bronze I

Joffe (1993) proposes that the archaeological evidence suggests a change in the organization of power between the Chalcolithic and the Early Bronze Age. While Chalcolithic politico-religious elites controlled access to raw materials and craft production, Early Bronze Age agrarian elites controlled agricultural products for trade. This implies a shift both in the type and the significance of the goods. In the Chalcolithic, objects were weighted with more symbolic significance, whereas in the

Early Bronze Age, they were viewed more as commodities for exchange. How might this be reflected in the zooarchaeological record?

If power in the EB I were equated with access to commodities, we would expect to see the introduction of, or increase in, products with commercial value (as opposed to symbolic value). Products with commercial value and relatively little symbolic weight would likely be more utilitarian items that lack iconographic associations. There are very few objects that suggest any sort of symbolic or iconographic association for animals or animal products in the EB I (except for the important case of donkey figurines).

A likely candidate for animal products with commercial value is wool. If wool became important in the EB IA, we would expect to see an increased importance of sheep in the EB IA and a maintenance of sheep to older ages. Milk and milk products might also provide commercial value, but their storage and exchange potential would be limited due to their tendency to spoil. Donkeys are also a strong candidate as products with commercial value. Their value lies in their capacity for transport and labor. If donkeys were a part of a commercial system, whether to carry the commercial products, or serving *as* the commercial products, we would expect to see an increase in donkeys in the EB IA. Artistic representations of laden donkeys suggest that the dichotomy between commercial and symbolic value, though in some contexts useful, may be somewhat overdrawn in other situations. However, these few and relatively crude figurines from the EB I seem less symbolically significant than the wealth of Chalcolithic iconographic and ritual paraphernalia.

Hanbury-Tenison (1986) hinted at both an ideological change and a change in lifestyle from the Chalcolithic to the Early Bronze Age. This study proposes that if such features as ideology, lifestyle, agriculture, and notions of ownership changed, then we should see a corresponding change in the animal economy. Such a change would manifest itself in the composition and structure of herds, and/or in peoples' perceptions of animals. Changing ideologies pertaining to animals are seen in the laden ram and milk-associated figurines in the Chalcolithic, and an increase in equid figurines in the Early Bronze Age. The importance of these animals ideologically might be found in their differential treatment at death, such as differential discard or intentional burial.

Hanbury-Tenison also suggests that the archaeological evidence points to a shift from corporate ownership in the Chalcolithic to individual ownership in the Early Bronze Age. Zooarchaeology may provide evidence for Hanbury-Tenison's concept of Chalcolithic corporate ownership in one arena, meat distribution. Central control and distribution of animals or animal products may be detected through analysis of butchery patterns and spatial variations in discard. A low occurrence of cut marks, relatively standard meat cuts, and spatial variations in taxa and body parts in different areas of the site[10] may indicate centralized, or corporate, organization of the distribution of meat. If evidence is found for Hanbury-Tenison's proposed corporate ownership of animals, then we can investigate if such patterns of ownership changed in the succeeding Early Bronze I. A shift from corporate ownership may be indicated by increased diversity in butchery patterns and a higher occurrence of cut marks (evidence for unskilled butchers). An even spatial distribution of taxa and body parts across a site and more generalized kill-off may provide evidence for provisioning on a small-scale, household basis.

Two aspects of Levy's proposed Chalcolithic system of risk management and gift-giving can be approached using zooarchaeological data. First, Levy proposes that cult centers such as Gilat served as regulating institutions for controlling the movement of herds across the landscape. Levy finds support for this system of risk management in the frequency of objects associated with herding, milk, and fertility (churns, animal and female figurines) from Chalcolithic sites. If milk products were indeed a component of this risk management system, we would see a higher occurrence of milking in the Chalcolithic, as opposed to the subsequent Early Bronze I, when this system supposedly collapsed. This would be evidenced in a higher occurrence of young male sheep/goat and a focus on adult females for milking.

The second aspect of Levy's system that might find support zooarchaeologically is his gift-giving model. Displays of wealth such as feasting would have been a component of the proposed Chalcolithic chiefdom-type societies (Levy 1995:238). Evidence for communal ritual or feasting would be found in special concentrations of bones from a single event (mirroring evidence of corporate ownership of animals or animal products), as opposed to the more common refuse scatter that normally characterizes spatial distributions at settlements. If animals or animal products were a component of Chalcolithic gift-giving, evidence might take the form of feasting in association with "prestige" products. These might include animals that hold a high value or investment, such as young (lambs, calves), rare (horses), hunted (gazelle, hartebeest) or costly (donkeys, cattle) animals. These might also include animal products from which prestige goods could be made, such as elaborately worked bone, hides, or wool textiles. Unfortunately, these types of animal products (with the exception of bone) do not preserve, which is likely why they have not been proposed as elements of the gift-giving system. Levy proposes that the Beersheva Chalcolithic system based on gift-giving gave way to a more commercial economy in the Early Bronze Age, influenced by contact with Egypt. The change from gift-giving to a more commercial economy in the Early Bronze Age would be indicated zooarchaeologically by evidence for changing strategies in animal exploitation to meet the demands of a market (as will be discussed in the following section).

2.2.1.4.2 Zooarchaeological applications to the Chalcolithic collapse

Whatever the factors were that contributed to the collapse of the Chalcolithic way of life, they clearly initiated some kind of social and ideological transformation. During this transitional time of the increasing contact with Egypt, a social reorganization occurred in southern Palestine. This reorganization is evident in

[10] Variations in taxa and body parts might include concentrations of choice cuts of meat, animals of particular ages, or rare/wild species in particular contexts.

significant changes in architecture, settlement patterns, demography, and material culture (pottery, figurines, etc.) from Chalcolithic and EB IA sites across the southern Levant. We also see some kind of shift in the ideological component of society, evidenced in the change in iconography and cult objects. These transformations may have been caused by an environmental change, an internal breakdown of the social structure of society, an external influence from Egypt, or (most likely) some combination of many causes. What is important is that these changes were significant and they, among other factors, ultimately contributed to the rise of the first walled settlements a few hundred years later.

Environmental factors that may have contributed to the Chalcolithic collapse are environmental degradation and a climatic shift. Grigson's (1995) review of zooarchaeological evidence from Chalcolithic and Early Bronze Age sites (discussed in the first section of this chapter) points to the Early Bronze Age as a period of marked economic change. She proposes that more marked change on the desert edge "suggests that environmental degradation may be at least one of the causes" of these differences (Grigson 1995:251). As discussed earlier in this chapter, the environment during the Chalcolithic and Early Bronze Age may have been moister than at present, becoming more arid at the end of the Early Bronze Age. While this proposed change does not coincide with the end of the Chalcolithic, it is possible that smaller scale environmental fluctuations occurred in this period. Their effects would have been more marked on the desert margin.

A climatic fluctuation would bring about stress if it were significant enough to cause changes in crop production, access to resources, the ranges of wild animals, and access to pasture lands. One means by which people cope with stress is by adopting risk minimization strategies. Methods for minimizing risk in a period of instability include diversification (broadening resources), increased storage, mobility, and exchange (Halstead and O'Shea 1989). If climatic shift caused the Chalcolithic collapse, we might expect to see the ensuing Early Bronze IA populations employing one or more of these strategies. Diversification can be observed zooarchaeologically by detecting a wider spectrum of taxa exploited. Increased storage is difficult to detect solely through zooarchaeological analysis[11], since animal products are perishable (unless meat were dried). Mobility would be indicated by an increase in sheep/goat and less pig-keeping. Finally, depending on the nature of exchange, exchange as a risk reduction strategy might be indicated by an increased use of donkey, an increase in products for exchange, such as wool and milk, or a focus on particular age groups for exchange of live animals.

As discussed above, the evidence for climate change is ambiguous, making it difficult to determine the role of climate change as a social stress at the end of the Chalcolithic. Regardless of the cause, changes in risk reduction strategies might be employed in any situation of stress (for example, increased warfare, changes in exchange relationships, etc.). Further complicating this analysis, the same zooarchaeological evidence can point to different conclusions. For example, an increase in donkey use might on the one hand provide evidence for mobility as a risk reduction strategy. On the other hand, it might be seen as indicating increased long-distance exchange or contact. In light of the potential equifinality of some of these results, it must be kept in mind that multiple interpretations are likely and many lines of evidence are needed to determine the most likely reading of the data.

As discussed, assessing the effects of possible climatic fluctuations is difficult for zooarchaeological analysis. The second model for the Chalcolithic collapse, Joffe's "attenuation of structures" model, presents even more difficulties. This model describes symptoms of collapse rather than a cause. While it is a reasonable model to describe the collapse, it cannot be tested with zooarchaeological data, and so will not be used in this analysis.

The commercialization model, on the other hand, might find some support zooarchaeologically. The commercialization model suggest that Egyptian interests in resources from the southern Levant caused a break-down of the socio-political

[11] Other types of archaeological research may reveal evidence for increased storage (large ceramic vessels, silos, etc.). However, to my knowledge, there is no such evidence for increased storage in the EB IA.

organization of Chalcolithic society. In this scenario, the Egyptians did not place the same symbolic/ideological value on such materials as copper, and so in light of emerging commercial interests, the meaning and value ascribed to these materials may have changed. From a zooarchaeological standpoint, if commercialization involved animals and their products, we would see a focus on particular species or ages for the export of live animals or their products. Some possible products for export over a long distance such as this include wool and hair products. Early Egyptian sheep were hairy (Bökönyi 1985) so wool products are a likely candidate for demand in Egypt. Commercialization involving the movement of people and goods across long distances would require an efficient means of transport. We therefore expect to see an increased importance of donkeys, either for transport of these products or as commercial objects for exchange.

### 2.2.2 Distinctions between the EB IA and the EB IB

#### 2.2.2.1 Archaeological evidence for distinctions within the Early Bronze I

While general descriptions can be made about the Early Bronze I as a whole, the finer distinctions between the different phases of the period (the EB IA and EB IB) are less well understood. The EB IA is characterized by unfortified villages that show no particular communal organization or plan (Braun 1996:235). The EB IB saw an increase in the number of settlements and a greater diversity in the size of settlements than was seen in the EB IA (Gophna and Portugali 1988). The EB IB also saw a move towards larger, more permanent villages with a return to rectilinear architecture (Ben-Tor 1992; Braun 1996) and more permanent structures, implying a more sedentary population committed to long-term occupation. After the shift to cruder, less specialized pottery from the Chalcolithic into the EB IA, the EB IB once again sees a return to more specialized production of pottery. A significant difference between these two periods in the southern Levant, especially the Shephelah and coastal areas, is the increased occurrence of Egyptian and locally-made Egyptian style artifacts (ceramics, flint tools) at southern Levantine sites in the EB

IB. Settlement in the hill country increased, presumably along with the advent of large-scale horticulture, including olive production for export of oil and wood in the Early Bronze Age (Finkelstein and Gophna 1993). The triad of agriculture, horticulture, and sheep and goat husbandry that defines the core of the traditional Mediterranean economy is thought to have come about during the Early Bronze I (Stager 1992). Ben-Tor claims that, in the Early Bronze Age, the "ox and the donkey were central factors in the improvement of the standard of living, in the accumulation of surplus, and in the promotion of trade" (Ben-Tor 1992:84).

2.2.2.2 Theoretical background to the Early Bronze I

Whatever the cause of the Chalcolithic collapse, the Early Bronze IA in the south represents a phase of recovery from that collapse, marked by a shift in settlement to areas with over 400 mm of annual rainfall. The subsequent Early Bronze IB saw a phase of expanded settlement throughout the southern Levant, marked by shifting settlement patterns and population agglomerations into larger sites. With the fortification of towns in the EB II, the settlement hierarchy became more complex, but the nature of political and economic organization is still confounding (Joffe 1993:58). Joffe sees the EB I as "the starting point for a pattern of development and collapse around the fundamental building block of small kin or lineage units" (Joffe 1993:2). He sees socio-political organization in the EB IB as based around domestic units, with a new system of ranking, exchange, and resource control that structured controls over labor "necessary for the maintenance of agricultural production and for the production of the emerging, but slow-growing, international commodities of olives and grapes" (Joffe 1993:53). The small household production of the EB IA developed in the EB IB with population agglomerations into larger scale, more productive groups. He sees the elites of the EB IA as relatively isolated with a low level of regional interaction, as opposed to the elites of the EB IB who partook in increased interaction and exchange. However, in all phases, Joffe still sees the main unit of production as the household (whether smaller or extended).

Horticultural specialization in the Early Bronze Age, meeting the demand for products such as wine, olive wood, and olive oil, has been seen as a factor in the rise of complex society in the area by stimulating trade, markets, administrative centers, and social stratification (Finkelstein and Gophna 1993). The diversified economy, where certain areas specialized in certain products, helped prevent regional isolation in the Early Bronze Age (Thompson 1999). Grain agriculture in the plains and valleys, horticulture in the hills, and sheep/goat herding in the grassy steppelands were activities to produce cash crops aimed not at surplus, but at trade between regions. Thompson argues that this inter-dependence of areas specializing in particular activities prevented consolidation of "the state" in the southern Levant (Thompson 1999).

2.2.2.3 Zooarchaeological applications to the Early Bronze I

The Early Bronze I is a period that merits a significant amount of further zooarchaeological research. Zooarchaeological research to date has mainly consisted of individual assemblage studies, and results vary from site to site: where some see no changes across the various phases of the Early Bronze Age, others see marked shifts in animal exploitation (Horwitz 1996; Horwitz and Tchernov 1989; Zeder 1990). The fact of the matter is that very little can yet be said about the Early Bronze Age economy, largely due to the small size of animal bone collections and to a frequent lack of distinction between the different phases.

The Early Bronze IA and IB are distinguished by such features as changes in settlement patterns, ceramic typologies, architecture, and population agglomeration. These significant social changes might find parallels in the subsistence economy between the two phases of the Early Bronze I. With a large sample size and clear stratigraphic distinctions between the EB I sub-phases, zooarchaeological analysis might provide insight into some of the social changes proposed during this period.

In the social environment of the EB IB, as people adjusted to increased sedentism and population agglomeration, we would expect to see increased social complexity. Tainter (1988:23) defines complexity as referring to:

> "such things as the size of a society, the number and distinctiveness of its parts, the variety of specialized social roles that it incorporates, the number of distinct social personalities present, and the variety of mechanisms for organizing these into a coherent, functioning whole."

Zooarchaeological data might provide useful in exploring specialization during the EB IB. Increased social complexity, along with sedentism and population agglomeration, might involve the development of a specialized pastoral component of society in the EB IB. The existence of a specialized herding component of society provisioning a settlement would manifest itself zooarchaeologically in a narrowing of ages of sheep/goat found at the site, depending on the herding strategy (for meat, milk, and/or wool provisioning). For example, in the case of meat, a consuming site would have a higher number of prime meat age animals (2-3 years old). If the site functioned as a meat provisioning source, we would see a complementary kill-off representing the older breeding population and young animals that died in infancy (Stein 1987).

The existence of specialized herders suggests secondary products provisioning. An increased use of female and adult sheep would imply an increased use of milk and wool. This would be reflected in distinct kill-off patterns, sheep/goat ratios, and male/female ratios, depending on the nature of production (for meat, milk, and/or wool). Specialized herding in the EB IB might also be reflected in an increase in sheep over time or in an increased focus on sheep/goat over other taxa.

It is also of interest to ask what effects the development of specialized herders, as well as the further disintegration of sheep/goat with the settlement, would have on the use of other meat providers, specifically cattle and pigs. Cattle, with their higher water and grazing requirements, and pigs, who are not usually an element of herding, would be more likely to remain at or near the settlement. We would therefore not expect to see changes in their exploitation as we would for sheep/goat. However, we might see a change in the use of other cattle products. For example, the removal of sheep/goat from the site by specialized pastoralists would free the remainder of the population to intensify other activities, including agriculture or horticulture. An intensification in agriculture might be reflected in an increased use of draught cattle. This would be evidenced zooarchaeologically in increased occurrence of foot pathologies, changes in body size among the cattle population, and/or an increase in the frequency of older individuals. Some agricultural strategies might also be reflected in a decreased use of pigs, who have been found to compete with humans for food in situations where agriculture involves intensive grain production (Redding 1991). Therefore, with the changing activities of a settlement over time, we might expect to see a fluctuation in pig numbers. However, pigs provide no secondary products, so we would not expect to see a change in their ages.

In sum, proposed differences between the EB IA and the EB IB include increased sedentism, population agglomeration, and increased specialization. Also among the differences between the EB IA and EB IB is the changing relationship with Egypt, which will be addressed in the next section (2.2.3). Zooarchaeological changes that would parallel social changes proposed between the EB IA and EB IB might be detected in the emergence of specialized herders. Evidence for such specialists would be found in particular age and sex patterns implying provisioning of certain animal products. Intensified agricultural activity would find evidence zooarchaeologically in the use of draught cattle. The presence/absence and fluctuating numbers of pigs at sites might indicate something about the permanence of the settlement as well as their involvement in agriculture and horticulture.

### 2.2.3 The relationship with Egypt in the Chalcolithic and Early Bronze I

#### 2.2.3.1 Archaeological evidence for the contact with Egypt

Contact between the southern Levant and Egypt is seen toward the end of the Chalcolithic, increases into the EB IA, climaxes in the EB IB, and finally declines in the EB II with the establishment of the first walled settlements in the southern Levant. This relationship between Egypt and the southern Levant nearly ceased in the EB III; in fact, almost no evidence of Old Kingdom Egypt has been found in the southern Levant (Ben-Tor 1991).

Contact between Egypt and the southern Levant during the Chalcolithic appears to have been informal and sporadic. Southern Levantine technologies and motifs are occasionally found at Lower Egyptian sites (Bard 1994; Caneva et al. 1987). The type of ceramic technology at El-Omari (roughly corresponding with the Chalcolithic in the southern Levant) is thought to resemble that of Ma'adi and perhaps Palestine (Bard 1994). A similar resemblance to Palestinian pottery has been found in ceramics from Heliopolis (also corresponding with the Chalcolithic) (Bard 1994). Evidence for Palestinian imports to Lower Egypt is found in the form of coarse-tempered ware at Ma'adi (Rizkana and Seeher 1987:31).

Occasional Upper Egyptian imports are found in Chalcolithic sites in the northern Sinai and southern Canaan (Oren and Yekutieli 1992). Lower Egyptian items are also found sporadically at sites in the southern Levant in the form of stone vessels, palettes, and maceheads (Joffe 1993:57). This sporadic contact during the Chalcolithic took place overland, a route proposed to have been used during periods that lack political centralization (such as the EB I and the EB IV/MB I)[12] (Stager 1992).

The EB IA witnesses a change in the nature of the contact between the southern Levant and Lower Egypt. While interaction seems to remain sporadic in nature as in the preceding Chalcolithic, possibly indicating down-the-line trade or infrequent visits of traders (Braun 1998), there is an increase in the variety of connections we see between the two areas during the EB IA. The EB IA contact with Lower Egypt involved both Canaanite influences on Egypt and Egyptian influences on Canaan; that is, in both southern Canaan and Lower Egypt there is evidence for assimilation of outside craft traditions into the local repertoire. In both areas during the EB IA it appears that the contact between Lower Egypt and the southern Levant had developed into one where people from both areas were living and working side by side at settlements from the Nile Delta to southern Canaan (Oren and Yekutieli 1992).

Egyptian contact in the southern coastal plain of the Levant is found in such evidence as Egyptian-style flints and pottery during the EB IA at En Besor Site H (Braun 1998; Joffe 1993:43) and in Egyptian style ceramics at Taur Ikhbeineh in the Gaza region (Oren and Yekutieli 1992). The Egyptian presence is evidenced both in Egyptian pottery and objects imported to Palestine, as well as Egyptian-style pottery made in Palestine. Early evidence for locally-made Egyptian style pottery is found at coastal sites, such as Nizzanim and Site H (Porat 1992). Finds of locally-made southern Levantine ceramics, Egyptian imports, and locally-made Egyptian style ceramics at Taur Ikhbeineh indicates that there was a population of Egyptians who were living and working among the local Canaanites as early as the EB IA (Oren and Yekutieli 1992).

A similarity has been suggested between the subterranean structures in the Beersheva Chalcolithic and those at Ma'adi in the Late Chalcolithic/EB IA (Bard 1994; Rizkana and Seeher 1989; Ward 1991). Parallels between Egypt and the southern Levant are found in similarities in ceramic styles between Ma'adi in the Delta and En Besor Site H in the southern coastal plain (Gophna 1992; Porat 1992), and similarities in copper fish hooks and the chipped stone industry from both areas (Stager 1992). It is also during the EB IA that southern Levantine raw materials such as copper are found in Egypt. Egyptian connections with EB I settlements along the southern Levantine Mediterranean coast (such as Afridar) indicate that an overland trade route may have existed alongside a maritime route between the southern Levant and Lower Egypt (Gophna 1995:279; Stager 1992).

The EB IB sees a shift in the nature of contact with Egypt. For the first time, substantial numbers of Upper Egyptian technologies and products are found at sites in the southern Levant (the material culture of Lower Egypt seen in the EB IA and

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[12] This is in contrast to the sea route, which Stager proposes was used during periods of state governments, such as in the EB II and III.

earlier has, by this time, been absorbed by Upper Egypt, and Upper Egyptian styles are now seen throughout Lower Egypt). Egyptian finds in southern Canaan, consisting of large quantities of pottery, some shells, jewelry, stone vessels, a flint knife from Azor, cosmetic palettes (Azor, Jericho), a cylinder seal (Gezer), and stone macehead (Megiddo) outnumber Canaanite finds in Egypt which comprise mostly pottery (Ben Tor 1991, 1992:94). The highest concentration of Egyptian finds is in southern Canaan and gradually decreases to the north. Locally-made Egyptian ware found in deposits with local southern Levantine ware suggests that Egyptians might have been living in the same settlements as the local Canaanites (such as at Nahal Tillah) (Kansa and Levy 1998; Levy et al. 1997).

Other sites where it is postulated Egyptian traders lived alongside local Canaanites during the EB IB include Tel Erani, Afridar, Arad, and Small Tel Malhata (Gophna 1987). En Besor is interpreted as a trading center occupied and administered by Egyptians that facilitated exchanges between the Egyptian state and the southern Levant (Gophna 1987; Ben Tor 1992:94). Recent findings indicate that what were thought to be administrative bullae from Egypt are actually locally-made (Ben Tor 1991), indicating locally-living Egyptians conducting their affairs at En Besor in an Egyptian style. It is thought that these administrative bullae sealed bags of agricultural goods intended not for export to Egypt but for local redistribution (because the bullae do not closely resemble any from Egypt) (Ben Tor 1991).

The Egyptian presence at Tel Erani is evidenced by locally-produced Egyptian style ware in the ceramic assemblage. The flint assemblage provides even stronger evidence for the presence of Egyptians: in addition to local Canaanite style flint tools and imported Egyptian tools, a portion of the flint assemblage is made up of Egyptian style tools made of local flint different from the type used to make local Canaanite style tools (Ben-Tor 1991). The exact duration of the Egyptian presence in the southern Levant during the EB I is not know; however, partly based on the nine EB I strata at Tel Erani, and correlations with Egypt's chronology, it has been suggested that it lasted 150-200 years (from the EB IA to the beginning of the EB II) (Ben Tor 1991; Porat 1992; Stager 1992).

During the EB IB, donkey caravans across the Sinai likely facilitated intensified contact between Egypt and the southern Levant (Stager 1992). Evidence for the importance of the donkey is found in figurines of laden donkeys from Early Bronze I sites (Epstein 1985; Ovadia 1992). Faunal bone evidence from these periods indicates a slight increase in bones of equids from the Chalcolithic to the Early Bronze Age in the southern Levant (Ovadia 1992). However, it is difficult to further refine this assessment for the EB IA and EB IB. The current picture suffers from a lack of published data and a lack of distinction between different phases of the EB I. Likewise, the published data from Egypt are few, most sites remarking simply on whether donkey bone were found and giving no numbers. The twenty equid bones from Ma'adi came from domestic donkey (Bökönyi 1995). As they constitute only 1% of the assemblage, they were probably not used for intensive transport. Judging from their small numbers, the author even going so far as to say they "seemingly had no particular importance at all" (Bökönyi 1995:496). At Tell Ibrahim Awad, a site in the Nile Delta dating to approximately the EB IB-EB III, equid bones in the Late Predynastic (~EB IB) make up 5.7%, decrease in the Early Dynastic (EB II) to 2%, and fall to 0.5% in the Old Kingdom (EB III). While these percentages are based on a relatively small sample (485 bones total), the high number of donkeys in the EB IB followed by a drop in the EB II and III fits well with the picture of increased exchange with the southern Levant during the EB IB.

The differing nature of EB IA and EB IB Egyptian presence in the southern Levant is perhaps best illustrated by the two phases of Early Bronze I occupation at En Besor (Gophna 1992). Gophna concludes that, during the EB IA occupation at En Besor Site H, the Egyptian occupation involves Lower Egyptians living in the southern Levant to meet the demand for raw materials and other goods such as copper, timber, and olive oil for export to Egypt. The close cultural interaction between Egyptians and local Canaanites is attested by ceramic styles which show domestic wares being produced in Canaanite styles with Egyptian techniques (Gophna 1992).

There appears to have been a break in settlement before the EB IB occupation at En Besor (stratum III)[13]. The EB IB occupation, which occurred after the Upper Egyptian absorption of Lower Egypt) reflects the more extensive and intensified Egyptian presence in southern Canaan in general. Gophna (1992:393) sees the establishment of an Egyptian outpost at En Besor during this period as an

> "organized, state-sponsored trade network operating under an Egyptian royal administration in Canaan...responsible for the continuous flow from Canaan to Egypt not only of essential raw materials but, and especially, of processed agricultural goods, like wine and olive oil".

The absence of any local Canaanite pottery at En Besor and the presence of only Egyptian style vessels among the domestic vessels further indicates that this "outpost" was occupied by Egyptians who had a different relationship with the local Canaanites than in the preceding EB IA when their ceramic styles show a higher degree of overlapping and blending. Gophna sees the different nature of the EB IA and EB IB settlements at En Besor as reflecting different groups of Egyptians. The earlier population was perhaps less formal and had a high degree of cultural interaction with the local Canaanites. The later population involved a more diverse and well-established network for extraction of goods, the intensification perhaps influenced by the expansion of the Upper Egyptian culture into Lower Egypt.

It is of interest to note that the situation in the EB IB at the Halif Terrace is of a different nature that at En Besor. Kansa and Levy (1998) see some blending of ceramic styles and little differentiation among contexts with Egyptian-style and local ceramics. The EB IB Egyptian presence at the Halif Terrace is, therefore, less convincing as an "outpost" for the organization of Egyptian-Canaanite trade. While any Egyptians at the Halif Terrace may have taken part in the export and import of

[13] Settlement fluctuations during the EB I are noted at other sites such as Nizzanim and Taur Ikhbeineh, which were completely abandoned after the EB IA.

goods, the social boundaries between them and the local Canaanites were unclear, indicating a much closer relationship than an Egyptian "outpost" would imply.

The nature of contacts between Egypt and the southern Levant throughout the Early Bronze I are not well understood. The scale, organization, and motivations for the establishment of a relationship between these two areas remain unknowns. While we have likely candidates for the goods involved in this trade, the trade of these commodities (wine, olive oil, tree resin, etc.) needs to be demonstrated with more physical evidence. These issues will be discussed further in the following section (2.2.3.2).

With the appearance of the first walled settlements in the EB II, the Egyptian presence in the southern Levant region disappears. It is suggested that at this time Egyptian commercial interests shifted northwards to the northern Levant, facilitated by increased use of a sea route; however, it is likely that they stopped along the southern Levantine coast (perhaps at Ashkelon) along the way (Stager 1992). Even so, while some southern Levantine pottery is found in Egyptian tombs in the EB II, the amount and diversity of Egyptian material in the southern Levant is greatly diminished in the EB II. By the EB III contact between Egypt and the southern Levant has subsided so that the only evidence is found in one Egyptian imported drop pot (Stager 1992).

#### 2.2.3.2 Theories regarding contact between Egypt and the southern Levant

The exact nature of the relationship between Egypt and the southern Levant in the Chalcolithic and Early Bronze I is not well understood. The nature of the contact was first hypothesized by Yeivin as a military presence (Yeivin 1960). Since then, various explanations include warfare, resource extraction, colonization, and peaceful co-existence. The fact that walled settlements do not appear until the EB II, after the first intensive contact with Egypt in the EB IB, suggests that the first intensive contact was peaceful, and shows a picture of co-existence rather than domination or colonization. Additionally, a lack of arrowheads and a predominance of sickle blades in the flint repertoire of the Early Bronze Age is seen as evidence against warfare (Ben-Tor 1991; Rosen 1988). Eliot Braun's review of evidence points to some type of commercial relations between Egypt and the southern Levant. These relations are *not* dominated by Egyptian administration. He gives evidence of locally-produced bullae from En Besor and "rustic" sealings based on Egyptian prototypes that suggest local administration was perhaps *based* on Egypt, but not necessarily *a part of* an Egyptian administration (Braun 1998).

Amnon Ben Tor proposes a settled population of Egyptians living side by side with the local Canaanite population in the southern Shephelah and western Negev during the Early Bronze I for a period of about 150 years (Ben-Tor 1991). He suggests that the population movement to the southern Levant had an economic motivation, aimed at the extraction of honey, wine, oil, bitumen, resins, dates, fish, sheep, cattle, textiles, copper, and slaves, all for export to Egypt (Ben-Tor 1986, 1991). However, he also admits that there is limited evidence in Egypt for the import of these types of goods. Given the high representation of household types of pottery at southern Levantine sites with indications of Egyptian presence, Ward (1991) agrees with Ben-Tor that the Egyptian presence reflects the colonization of the southern Levant as a commercial venture. However, he criticizes Ben-Tor's list of exports, claiming that there is no evidence for the use of slave labor at this time, and that Egypt was already rich in common agricultural and animal products (fish, sheep, and cattle) and would find no need to import them (Ward 1991). He concedes that honey, legumes (lentils, chickpeas), and wine may have been exported to Egypt in small amounts. However, he sees the crucial exports as copper, bitumen, coniferous wood and wood products, and turquoise.

The role of metalworking in the Chalcolithic debt-based system stands in contrast to the industrial metalworking proposed for the Early Bronze I. Levy describes the EB I contact with Egypt as a World Systems type model (Levy et al. 1997). This involves the emergence of a powerful entity (a "core") that exploits and extracts tribute from weaker communities ("peripheries"). In this asymmetric relationship a unified core has a monopoly on politically important goods, by which it controls peripheral elites. Since the peripheral elites can only acquire these politically important finished products from the core, they are placed in a dependent position to the core. The peripheries, which are less unified than the core, then end up compete with each other to be exploited in a system of unfair trade.

2.2.3.3 Zooarchaeological applications to the relationship with Egypt

The relationship between Egypt and southern Palestine may very well have been one of the factors which contributed to the collapse of the Chalcolithic way of life in the southern Levant. However, it holds potentially much more significance than simply contributing to the Chalcolithic collapse. Contact with Egypt may have also had a direct effect on rising complexity in the southern Levant, where Egyptian contact is seen as compelling local processes toward increasing social complexity (Joffe 1993:54). The relationship between the southern Levant and Egypt in this early period changed the history of the Levant, for it contributed to the establishment of an international network of contact and trade, as well as to the subsequent rise of "urban" areas in the southern Levant. The establishment of a network of international contact, whether for trade, resource exploitation, or colonization certainly had far-reaching effects on the organization of southern Levantine economic activities.

The end of the Chalcolithic was a time of low levels of contact between the Egypt and the southern Levant, a relationship that developed in the EB IA and EB IB. Household production was still the norm in the southern Levant, but trade and contact grew, facilitated by domestic donkeys (Joffe 1993). Whatever the nature of the contact, donkeys are a key factor to understanding the changing relationship between Egypt and the southern Levant in the Chalcolithic and the EB I. Equids in Ma'adi (Bökönyi 1985), and laden donkey figurines from the EB I (Ovadia 1992) suggest an importance of trade, transport, and long-distance travel in the Early Bronze Age.

This study will use zooarchaeological data to test two theories of Egyptian-southern Levantine contact. The first theory is that the EB IB Egyptian presence in the southern Levant involved commercial relations. This relationship between the two regions involved trade or export of goods, strong candidates for which are wine, olive oil, tree resin, copper, and dead sea minerals. This trade most likely took place, at least partially, on an overland route across the north Sinai. Does this picture of the EB I relationship between Egypt and the southern Levant find support in the zooarchaeological record?

The most obvious area where zooarchaeology would be relevant is in the means of transport for these proposed items of exchange. If the relationship between the two areas became more intense during the EB IB and involved exchange of bulk goods such as wine, olive oil, and copper, we would expect to see an increased use of animals for transport, particularly the donkey, in the EB IB. This single addition to the animal economy of the Early Bronze I, the donkey, with its potential for long-distance travel, would have had far-reaching social, economic and ideological consequences, both on a local and on an international level.

If, as Ben-Tor (1991) proposed, the commercial relations between Egypt and the southern Levant also involved food, such as fish, sheep/goat, and cattle, we would detect an animal management strategy that selected for certain taxa or age groups. If, for example, animals were exported on the hoof for meat or other products, we might see an absence of animals of a certain age in the bone assemblage of the site from which the animals were taken. However, evidence for this would only appear in the age data if the selection of one age group occurred on a regular and long-term basis. We do not know if the relationship with Egypt involved any regular or organized export of animals (or other goods, for that matter). Any conclusions regarding the nature of export will be tentative.

If animal products (rather than live animals) such as wool were a component of export, we might see an increased importance of sheep and older individuals into the EB IB, when the contact is said to have been highest. Early Egyptian sheep were hairy (Bökönyi 1985), so perhaps wool or wool products were a component of export to Egypt. Age and sex demographics among sheep/goat can provide rather convincing evidence for wool production. However, the demonstration of wool production is not necessarily a demonstration of wool export. If animals were being exported on the hoof for their wool we might see a predominance of younger animals in the assemblage, the older ones sent away for their wool. However, this kind of survivorship with a majority of young is typically interpreted as a meat-focused kill-off. The above examples demonstrate the difficulty in dealing with export, where an absence of data can be relevant, but can be interpreted in many different ways.

The second theory that this study will test using zooarchaeological data is that of an Egyptian colonial presence in the southern Levant during the EB I. In the case that the southern Levant was colonized by people from Egypt, we might find different subsistence activities at sites where Egyptians were present. Presuming the relationship was one of colonial or military occupation and exploitation, suggesting a hierarchical relationship, we might expect to see certain meat cuts being provided for the Egyptian colonists or military, who might not have performed subsistence activities such as herding. Another area where we might expect to see differences in a colonial situation is in spatial patterning of refuse. First, as mentioned above, we might see different carcass parts in "Egyptian" and "Canaanite" areas of the site (as discussed above). Secondly, we might see a preference for a particular age group, species, or body part that would reflect the dietary preferences of the colonists or their demand for more costly or difficult to obtain food items.

If, on the other hand, the southern Levantine - Egyptian relationship at these sites was one of co-existence and/or integration, we would see no indication of tribute or provisioning that might be found in the hierarchical system of military or colonial occupation. At a site such as the Halif Terrace, where it is thought that Egyptians and southern Levantine people were living side-by-side (Levy et al. 1997), we might expect to find differences in butchery patterns, in choices of animals (use of pigs, for example), or in ages that would reflect different food preferences. However, we would see fewer distinctions than we would expect in a militaristic colonial case, an overlap that would indicate unclear "ethnic" boundaries between the Egyptians and the southern Levantine people. Spatial evidence must be interpreted with caution, for a lack of outstanding evidence which can be interpreted as coexistence might simply be indicating that no differences can be detected spatially in the animal bone refuse.

### 2.3 Closing remarks

To reiterate, the first half of this chapter discussed previous zooarchaeological research regarding the Chalcolithic and Early Bronze I. The second half of this chapter reviewed the prevalent theories regarding three aspects of this transition. The chapter then elaborated on the test predictions introduced in Chapter 1. The following chapter will present the methods that will be used to approach the three research questions. Chapter 6 will place the results in context with the above hypotheses, and their support or negation of the proposed predictions will be explained. As stated earlier, the goal of this study is to test theories regarding aspects of the Chalcolithic-Early Bronze I transition using zooarchaeological data. The above discussion acknowledges the difficulties, ambiguities, and pitfalls inherent in applying zooarchaeological data to addressing these questions. However, as I hope to demonstrate, zooarchaeology provides an important and potentially valuable avenue for investigating the Chalcolithic-Early Bronze I transition.

# Chapter 3

# Analytical Methods

In the preceding chapter I reviewed theoretical and zooarchaeological approaches to social change in the Late Chalcolithic and Early Bronze I in the southern Levant. I defined four research areas that merit further study, and I reviewed predicted outcomes of the application of zooarchaeological data to the prevailing theories. This chapter describes the methods zooarchaeologists normally employ in the analysis of animal bones from archaeological sites in the proto-historic Near East. The selection of methods emphasizes facilitation and clarity in assessing ancient production and consumption practices. First, section 3.1 describes methods for determining the limitations of the local environment in shaping both the availability of species and human choices regarding husbandry practices. Section 3.2 describes methods for assessing meat consumption. This is related to section 3.3, which describes how past studies have recognized secondary products exploitation in the zooarchaeological record. Finally, section 3.4 details methods for determining differential discard of animal remains (from both meat and secondary products).

## 3.1 The local environment

This section focuses on the role of the environment in determining the availability of animals in the local environment, and in shaping human choices regarding animal exploitation and management. It is important to determine to what extent the environment plays a role both in structuring the animal bone assemblage and in shaping activities regarding animal management. Three aspects of this analysis include the faunal spectrum, animal size, and pathologies related to the environment in which an animal lives. After determining the nature of the assemblage in the context of the site's environment we investigate production and consumption practices unique to a particular site, society, and period.

### 3.1.1 The faunal spectrum

The term "faunal spectrum" describes the entire corpus of animals present in the excavated archaeological assemblage. The faunal spectrum is, therefore, *not* a fully representative cross-section of the universe of fauna found in the local environment of the site in question. As archaeological assemblages are largely shaped by human activity, the faunal spectrum from an archaeological site will mainly be a human-selected portion of the universe of potential taxa in the area, depending on such factors as hunting practices, herding activities, and dietary preferences.

#### 3.1.1.1 Taxonomic richness

Taxonomic richness refers to the number of different taxa within an assemblage, in relation to the number of individuals per taxon. It is useful for determining the productivity of the local environment as well as the decisions of humans regarding exploitation of their environment. The formula used is: ($d=S-1/\log_e N$), where S is the number of different taxa in the assemblage and N is the total number of identified specimens (Grigson 1995a). Because taxonomic richness is concerned with the diversity of taxa in the ancient environment, rodents have been left out of the calculation because they are often intrusive and probably had little to do with ancient animal exploitation.

#### 3.1.1.2 The expected spectrum: Domestic animals

The presence of certain wild animals at each site can be said to more or less reflect the capacity of the natural environment to support certain taxa. In this study, the local environment at each site, together with previous analyses of Chalcolithic and Early Bronze Age faunal assemblages from southern Levantine sites, gives us a fair idea of what can be expected. The faunal spectra from Early Bronze Age and Chalcolithic sites in this area of the southern Levant are generally the same in terms of taxa represented; however, they differ in relative proportions of taxa (see Table 10). The predominant species during the Chalcolithic were domestic forms of sheep, (*Ovis aries*), goat (*Capra hircus*), and cattle (*Bos taurus*). These three species are represented in varying proportions at all sites in this area during both the Chalcolithic period and the Early Bronze Age (Horwitz and Tchernov 1989). All three species are well-adapted to the environment of the southern Levant, and were domesticated thousands of years before the period in question. Another domestic species which is present in both Chalcolithic and Early Bronze Age assemblages is pig (*Sus scrofa*). Much has been written about the presence/absence of pigs at southern Levantine sites (Hesse 1990; Grigson 1987). There appears to be a highly environmentally-dependent distribution of pigs in this area: pigs are present at sites in areas which received over 350 mm annual rainfall, and generally absent from sites which receive less than that amount (Grigson 1995b:254). However dietary preferences or cultural taboos might also be seen as factors in the choice of pig use in southern Levantine sites (Hesse 1990; Zeder 1996).

In addition to these four taxa, all common meat sources in the ancient Near East, the other expected domesticate is the dog (*Canis familiaris*). The dog is the earliest Near Eastern domestic animal and is fairly ubiquitous in Holocene faunal assemblages in the region. Dog remains, which are usually found few in number, are often disposed of in a different manner than the bones of food animals, and are sometimes even intentionally buried (Hesse and Wapnish 1993). Dogs are thought to have been used primarily for non-food-related purposes in the ancient Near East, for herding, protection, and companionship.

Equid remains are found in small numbers at most Chalcolithic and Early Bronze Age sites (see Table 10). Previous excavations at the Chalcolithic sites of Shiqmim and Grar have produced remains of what is thought to be domestic horse (*Equus caballus*), (Grigson 1993, 1995a; Whitcher et al. 1998). Additionally, Davis found what he identified as domestic horse in Early Bronze Age deposits at Arad (Davis 1976). Together, these Chalcolithic and Early Bronze Age remains are the earliest finds of domestic horse in the region[14]. Methods for distinguishing horse bones from those of other equid species are detailed in section 3.3.3.1 below.

A major difference in the faunal spectra of the Chalcolithic and the Early Bronze Age is found in the use of the domestic donkey (*Equus asinus*) in the Early Bronze Age. The donkey is thought to have been domesticated from the wild ass (*Equus africanus*) in the general area of Egypt and western Asia perhaps sometime before the early third millennium (Clutton-Brock 1992:65). While bones of domestic donkey are found in small numbers in many Chalcolithic and Early Bronze Age sites (Ovadia 1992; Ducos 1968), by the Early Bronze Age and later, donkeys had become the principal means of transport in the Near East and Egypt (Grigson 1993). To detect the increasing role of the donkey in southern Levantine animal exploitation, we would expect to see two changes in the zooarchaeological record from Early Bronze Age sites. First, we would expect to see an introduction of donkeys to sites with no previous evidence for domestic equids. Secondly, we might expect to see an increase in equid usage into the Early Bronze Age, depending on the motivations of the people exploiting them. Ovadia notes slightly higher numbers of donkey bones at Early Bronze Age sites in Israel (Ovadia 1992). However, due to discrepancies in quantification, this slight increase is difficult to substantiate based solely on relative proportions of taxa (see Table 10 for an example of the variation in equid numbers).

3.1.1.3 The expected spectrum: Wild animals

There is a wide range of wild taxa which can be expected in this area during the Chalcolithic and Early Bronze Age. One of the most common is gazelle, of which two forms are expected, the mountain gazelle (*Gazella gazella*) and the smaller desert gazelle (*Gazella dorcas*). Differences between the two species are size, horn core shape, and certain cranial features (Tchernov et al. 1986/7). *G. gazella* horn cores

[14] The assignation of these remains to domestic horse is based solely on the fact that wild horses are not known from this area during the Holocene. However, recent studies indicate that the natural range of the wild horse extended much further than was previously thought (Levine 1999; Clutton-Brock 1992).

have a wide groove on the frontal margin of the horn core, while both *G. gazella* and *G. dorcas* have a groove on or near the nuchal margin (Ducos 1968). In addition, the *G. gazella* horn core cross-section is elliptical, while that of *G. dorcas* is egg-shaped with a wider nuchal margin (Tchernov et al. 1986/7).

Another wild ungulate species whose bones are sometimes found at archaeological sites from this period is the wild aurochs (*Bos primigenius*), a large form of wild cattle which survived in the Near East at least until the third millennium BC (Grigson 1989b). Three deer species might be expected at these sites during this time. The largest of the deer species, the red deer (*Cervus elaphus*), is found in sites extending into the southern Levant until Late Pleistocene. However, in the Holocene, red deer is much less common, although some small populations of red deer might have persisted in forested areas until the Middle Ages (Uerpmann 1987:64). The occurrence of red deer bones in Chalcolithic and Early Bronze Age assemblages will likely be low. More common are remains of the fallow deer (*Dama mesopotamica*), a species better adapted to hot climates, whose remains are found at southern Levantine sites into the Bronze Age and later (Uerpmann 1987:60-63, Table 11a). Red deer and fallow deer bones in the southern Levant are rather similar in size and morphology. Distinction between the two species in this study was made in the first instance based on comparison with a reference collection. The classifications were then reexamined using distinctions laid out by Lister (1996). Another deer species found in small numbers is the tiny roe deer (*Capreolus capreolus*).

Bones of hartebeest (*Alcelaphus buselaphus*) are also found in small numbers at Chalcolithic and Early Bronze Ages sites. This large herd animal was once a common species in the southern Levant, particularly around reliable water sources. The present day range of the hartebeest is restricted to south of the Sahara Desert (Uerpmann 1987:87). Among other animals whose remains we might expect to find at archaeological sites in this part of the southern Levant are hippopotamus (*Hippopotamus amphibius*). In the Holocene, hippopotamus skeletal remains are found in sites from the Chalcolithic through the Iron Age[15] and occur only in the region of the coastal plain (Horwitz and Tchernov 1990, Fig. 4). It is thought that Nilotic faunas such as the hippopotamus, crocodile, perch, and soft shelled turtle arrived in the coastal plain area of Israel during the last glacial period when the pelusiac and other Nile tributaries extended close to the coastal rivers of the southern Levant (Horwitz and Tchernov 1990). Hippopotamus and ostrich (*Struthio camelus*) provide valuable products: ivory and egg shells, respectively. Ivory objects and statuettes and incised ostrich egg shells are among the known assemblage of Chalcolithic prestige items. Other wild taxa found at archaeological sites during the Chalcolithic and Early Bronze Age in the southern Levant are fox (*Vulpes vulpes*), hyaena (*Hyaena* sp.), cat (*Felis* sp.), and hare (*Lepus* sp.). Also expected is a range of rodent, bird, and fish species.

### 3.1.2 Animal size

Animal size can vary, depending both on human selection and on the natural environment. Determining if animal size might be related to the local environmental conditions requires inter-assemblage comparisons of measurements. Comparison is made using a selection of measurements. After determining the most prevalent measurement for each element, the measurements for each element are averaged, and the averages are plotted for each population. Fused elements are used in all cases, to limit comparisons to the adult population in each site. The largest samples (and therefore the most reliable) are those measurements taken on the early-fusing elements, the elements which preserve the best (such as the distal humerus and distal tibia). While the distal epiphyses of these elements might fuse early, shaft growth is not yet complete. To limit possible variations due to post-fusion shaft growth, most measurements for comparison are taken on the distal or proximal ends of bones. The

[15] Remains of hippopotami are also found at sites from the Middle Pleistocene through the Mousterian period, after which there occurs an lapse in finds until the Chalcolithic (Horwitz and Tchernov 1990).

elements used fuse at different times, but the same measurements are used in all populations. The distal scapula and the distal tibia are among the earliest fusing elements. They should thus provide a useful sample which includes fused elements from both males and females (even if males were killed off at a younger age, they might already have some fused elements for comparison).

Due to the potential for exploitation of wild cattle during the Chalcolithic and Early Bronze I, and the possible presence of castrates in the domestic herds, log differences can be used to determine if wild cattle are present in an assemblage. The measurements of a known wild cow from Denmark have been used in past studies by Grigson to document changes in cattle size over time (Grigson 1989b). Measurements from this Danish female aurochs are used as a standard with which to compare other cattle specimens (a list of measurements on the Danish *Bos primigenius* can be found in Grigson (1989b:81, Table 1). The method takes the Log (base 10) of the standard and subtracts it from the Log (base 10) of the archaeological specimen. This method is useful because it allows for all measurements to be plotted on a single graph.

### 3.1.3 Skeletal disorders

Skeletal disorders on animal bones can sometimes provide information about the living conditions in which people placed their animals. Abnormalities related to pasturage, nutrition, and penning are often found on the teeth and foot bones of herd animals. Pathological exostosis on the bones of the feet (the phalanges) could result from overcrowded conditions or penning, or from grazing over poor and expansive, or rocky pasture. When pathologies such as osteoarthritis occur on the foot bones of cattle, in particular, they might be related to the cattle having been used for draught (Baker and Brothwell 1980:117). In either case, foot pathologies are sometimes related to unusual, excessive, or unhealthy activity on the part of the animal.

Among domestic animals, oral pathologies can be related to such factors as over-crowded pasturage where infection spreads easily, pasturage low in nutrients, and abrasive material in the diet (Baker and Brothwell 1980:136). Swollen root tips are related to periodontal infection, possibly resulting from chronic, low-grade infection (Baker and Brothwell 1980:151). Among domestic herd animals, low-grade infection might be caused in part by poor pasture or crowded living conditions. Dental calculus, or tartar build-up, normally found on the teeth of mature bovids (Miles and Grigson 1990:560), both wild and domestic. Dental calculus leaves a metallic luster on the teeth of ruminants, and in some species has been related to a lack of friction from food during mastication (Baker and Brothwell 1980:152). While dental calculus does not seem to be a predominant feature of periodontal disease (Miles and Grigson 1990:560), in some cases where it has been observed it may be related to diet and pasture. For example, dental calculus build-up was associated with extreme periodontal disease noted among sheep from North Ronaldsay, Orkneys (Scotland), where its build-up could be attributed to the intake of sand in grazing near the shoreline (Baker and Britt 1984).

### 3.2 Primary production strategies

The term "primary products" normally refers to any products for which the animal must be killed, the most prevalent primary product being meat. Other primary products are sinews, bone marrow, bone tools, blood, horn cores, and leather. While methods to assess consumption will focus on the use of meat, the use of other primary products, such as sinews, bone marrow, bone tools, horn cores, and leather can be inferred through some butchery and fragmentation patterns.

Many analysts infer the importance of various species in the human diet from the relative percentages of the bones of those species in the animal bone assemblage. The method of quantification is a key factor in assessing the abundance of each species in the assemblage, and thus in interpreting meat usage. This section discusses quantification methods and their use in zooarchaeological analysis. This is followed by a brief discussion of the significance of meat weight in interpreting meat consumption. Finally, methods of assessing butchery and fragmentation are discussed.

### 3.2.1 Quantification

Quantification in zooarchaeology generally follows two methods, MNI and NISP. MNI refers to the minimum number of individual specimens represented by the bone assemblage. At the most basic level, MNI pairs the corresponding left and right elements in the assemblage in an attempt to not count the same individual animal twice. For example, if you had 10 sheep left humeri and 15 right sheep humeri, the MNI would be 15 sheep. However, not all analysts calculate MNI in the same way. Because it is a derivative measure (derived from bone counts), it is very subjective and is used inconsistently. While some zooarchaeologists calculate MNI based on the entire assemblage as a whole, others separate the bones by stratum, or even further by context. Some analysts separate the fused and unfused bones before calculating left and right, for a fused left and unfused right of the same element clearly do not come from the same individual. As the divisions become finer, so the resulting MNI becomes greater. Inter-assemblage comparisons based on quantification using MNI thus become extremely difficult to undertake unless all numbers are given and the method of MNI calculation is explicitly detailed. While MNI quantification can become very complicated with large assemblages, it is quite useful in certain cases, such as a context related to a single event, an ephemerally-inhabited site, or a deposition in which it is suspected that whole carcasses were deposited.

The other popular method of quantification in zooarchaeological analysis is NISP. NISP as defined by Lyman is "the number of identified specimens in a collection, where 'identified' usually means identified to taxon, but may mean identified to skeletal element represented" (Lyman 1992:511). NISP refers to the *total* number of bones, bone fragments, and teeth in the assemblage. NISP is in a way the opposite of MNI in that it represents the *maximum* number of individual animals which might be represented by the bone assemblage. Thus, as calculation of MNI is based on more and more sub-divisions, it gradually approaches the NISP calculation. While NISP is less variable and subjective than MNI, it too has its downfalls. For example, pigs give birth more frequently and have more bones in their skeleton than other common domestic meat animals (specifically, domestic ungulates). If each bone is taken to represent one individual animal, the number of pigs at a site will be inflated, while the number of horses (who have fewer bones than other domesticates) will be under-represented. In spite of these potentially biasing factors, NISP as the less subjective method seems the more appropriate of the two methods for large assemblages of long occupation, as well as for inter-site comparisons of relative abundance of various species.

The quantification method chosen for this study is a marriage of MNI and NISP, with more emphasis placed on NISP. It is based on a method used by Caroline Grigson, and is therefore useful for inter-site comparisons within this study (since Dr. Grigson provided the data for one of the sites used in this study). A "1" in the NISP category of the catalogue refers to one identified specimen of a particular taxon (see Appendix A). To account for the possibility that a single animal might be represented by more than one element, any additional bones that were found to obviously pair or articulate with the first "1" are noted with a "0" in the NISP category. This was done so that a rough MNI count can be taken, and any individual with more than one bone which obviously belong to it will not be counted twice. This method was undertaken on a context-specific level; that is, no attempt was made to pair or articulate bones from different loci. This method can therefore be seen as a *very* maximal use of MNI quantification. It is particularly useful because it accounts for such potential problems as dog skeletons. Quantification including dog skeletons, if based strictly on NISP, would inflate the number of dogs to an unrealistic proportion. Using the present method, all dog skeletons are counted as "1".

### 3.2.2 Relative abundance of taxa

The numbers and types of species represented in an assemblage depends on a variety of factors, such as differential disposal in antiquity, soil conditions over time, gnawing and burrowing activities, excavation retrieval strategies, and quantification methods. In spite of these potential biases, it is one of the most common ways a set of data is presented in zooarchaeological analyses. Quantifying the relative numbers of taxa is, thus, often the only method which can be used for comparison between sites. A loose interpretation and general comparison between sites can help us see which animals were exploited more intensively than others. A high occurrence of a particular species at a site usually occurs because that species contributes to the diet of the people who inhabited the site, the bones representing the remains of butchery and discard for primary animal products such as meat, hides, blood, marrow and sinews, to name a few. The bones of animals used for labor, such as the horse, donkey and camel, are often found in small numbers because fewer animals are kept for this purpose than are kept for food (Davis 1987).

It must be remembered, however, that although the bones of a particular species might dominate the assemblage, that species did not necessarily provide the most meat. Many zooarchaeological analysts use calculations of meat weight to describe the relative abundance of various species in an assemblage. Cattle can provide up to nine times, and pig up to five times, more meat than a sheep/goat (Clark and Yi 1983). Therefore, an assemblage with 20% cattle and 80% sheep/goat could hypothetically represent a diet made up predominantly of beef (see Grigson (1995b:260-262, Table 1) for calculations of meat weight from Levantine sites from the Neolithic through the Iron Age). While meat weights are not calculated in this study, the contribution of beef to the diet is kept in mind when discussing patterns of meat consumption.

### 3.2.3 Kill-off patterns

This section addresses kill-off patterns in reference to what they indicate about meat usage at each site. The age at which an animal was killed provides information about the environment, the importance of that animal for meat or other products, and decision-making on the part of the herder, butcher, or consumer. The following methods for assessing kill-off patterns will also be useful for investigating secondary products exploitation (discussed later in the chapter). As domestic animals comprise the majority of the bone assemblages in Near Eastern Chalcolithic and Early Bronze Age sites, methods for aging are limited to domestic species, namely, sheep/goat, cattle, and dogs. Methods used for determining mortality of equids are also included in this discussion. To determine the age at which the animals were being killed, two common methods are used here: bone fusion stages and mandibular tooth eruption.

#### 3.2.3.1 Fusion stages

Bone fusion stages provide a general idea of the pattern of kill-off within a species up to the age of maturity. The method is based on the fact that, as mammals mature, their bones undergo a consistent pattern of ossification. An animal's bones will continue to grow throughout the animal's youth. When a long bone, for example, reaches its maximum length, the articular ends (the epiphyses) of the long bone fuse to the shaft (the diaphysis). Epiphysial fusion occurs at different stages depending on the species and the element. For example the distal (bottom) end of the humerus of a sheep fuses by 10 months of age, while the proximal (top) end of the humerus fuses between 3 to 3.5 years (Silver 1969). Therefore, a complete sheep humerus found in an archaeological assemblage that has an unfused proximal end and a fused distal end is known to have died somewhere between 10 months and 3 years of age. Bone fusion is thus a useful method to zooarchaeologists for determining the broad kill-off pattern of a species up to maturity. Bone fusion stages are an especially useful method of aging among smaller assemblages in which tooth data might be insufficient for determining mortality patterns (aging using tooth eruption and wear is a more informative method, and is discussed in the next section).

Age categories for bone fusion stages in this study are derived from increments given in Silver (1969). The database layout employed in this study (Appendix A) has two columns, N and O, representing the fusion status of the proximal and distal ends of bones. A "y" means the end is fused, while an "n" means it is not fused. A "y/n" indicates that the epiphysis is fusing, but the fusion line is still visible. While this distinction was made in the database, in quantifying fused and unfused elements, the "y/n" specimens are considered to be fused ("y").

Using bone fusion stages to determine cull patterns presents a number of analytical drawbacks. One is that the latest-fusing long bones fuse at or soon after the point of maximum growth (adulthood). This fact renders inaccessible the mortality profile for the part of the population which survived beyond that particular age. Another downfall of this method is that the age groups for various species are broad and overlapping. Thus, any kill-off profile obtained using bone fusion must be taken as a rough (and incomplete) reflection of the actual mortality pattern. Finally, the nature of the fusion categories themselves is vague. If an element is unfused, we can only say that that individual was under a certain age. For example, a proximal portion of a sheep humerus with an unfused epiphysis can only tell us that the animal died under a certain age. In this case, that age would be under 3-3.5 years, the latest age for which information can be noted (the proximal humerus is one of the latest fusing elements). In spite of these downfalls, bone fusion stages are useful for assessing kill-off patterns, up to adulthood, especially as evidence to substantiate mortality patterns detected through examination of mandibular tooth eruption and wear.

#### 3.2.3.2 Tooth eruption and wear

Both the deciduous and the permanent teeth of mammals erupt according to a more or less specific pattern. Once fully erupted, permanent teeth wear down slowly over the course of an animal's life. Over time, wear patterns are created in the enamel on the occlusal surface (the biting surface) of the premolars and molars. These patterns have been documented in different ways for use in zooarchaeology (Bull and Payne 1982; Grant 1982; Payne 1973). The method of Payne (1973) for determining the age of sheep/goat has become widely used in Near Eastern zooarchaeological studies. Grant (1982) has also detailed eruption phases for sheep/goat, as well as for cattle and pig. The high-crowned teeth of sheep/goat and cattle are especially useful for wear pattern analysis because they wear down continually throughout the individual's life. Tooth wear thus provides information about mortality patterns within an entire population because it applies to both older and younger individuals. In this way, mandibular tooth eruption and wear is a more informative and inclusive method than bone fusion for determining age at death.

Tooth eruption and wear patterns are a popular method of analysis because durable mandibles and mandibular teeth are often the most abundant elements recovered at a site. The relative popularity of this method facilitates useful comparisons between assemblages. With sheep/goat in particular, eruption and wear analysis has been found useful in assessing the importance of secondary products and in defining specialized cull patterns (Wattenmaker 1987; Zeder 1991). By plotting the survivorship curve of individuals of a particular species at a site, certain methods of exploitation can be postulated. In a widely-used study of mandibular tooth eruption and wear, Sebastian Payne (1973) designs models for kill-off patterns of sheep and goat with the different primary aims of meat, milk, and wool (see Figure 9). In a mainly meat-based economy the survivorship curve is predicted to reflect a high kill-off of young animals into the third year, with a smaller population of mature animals being kept as a breeding population (see Figure 9a). In a milk-based economy, there would be a sharp decline in very young animals, and a maintenance of the majority of the females for milking (see Figure 9b). In a wool-based economy, a majority of adult animals is predicted (see Figure 9c). These models are idealized, for early domestic animal economies will rarely have a sole aim of meat, milk, or wool production, but rather will be a mixture of two or three of these practices, in which case the picture becomes less clear. However, these models are useful for determining the combination of strategies people might have chosen. Payne's models are used in this study as a visual comparison to facilitate a discussion of kill-off at the three sites under analysis.

This study uses two published sources to determine mortality patterns among sheep/goat through tooth eruption and wear analysis, that of Payne (Payne 1973) and of Zeder (1991:93), who expanded on Payne's method. Due to a small number of teeth in the assemblages, this study uses bone fusion to age cattle, pigs, and equids.

### 3.2.4 Food preparation: fragmentation and butchery

Animal consumption, like many other aspects of zooarchaeological analysis, is difficult to assess because of the taphonomic processes which affect animal products. Certain primary products are more difficult to detect than others in the zooarchaeological record. While leather is rarely preserved archaeologically, animal bones often preserve well and provide such lines of evidence as cut marks, bone fragmentation patterns, and intentional modification by humans. These characteristics can be used to infer whether animals were utilized for meat, leather, sinews, or bone tools.

In this discussion, the term "butchery patterns" pertains to activities involving the processing of animal carcasses by humans for any primary product, whether meat, skin, marrow, sinews, or bone tools. Butchery practices to obtain these products involve various activities, including skinning, slicing, dismembering, bone crushing, and chopping into portions for distribution or for cooking. Because these efforts often result in broken and sliced archaeological bones, this investigation focuses on two methods of interpreting butchery patterns: fragmentation patterns and cut marks.

3.2.4.1 Bone fragmentation

Fragmentation describes the "mechanical disassociation of skeletal elements along non-articulation planes or non-joint-related planes" (Lyman 1992:509). Fragmentation is an important element of zooarchaeological analysis because it can reveal information about both natural taphonomic processes and human activities which affect bone. Natural processes which affect bone fragmentation include gnawing by rodents, crushing by carnivore teeth, and breakage through wind, dryness, and trampling. Human actions include butchery, crushing for marrow extraction, breakage for particular functions (such as making soups), and various methods of discard. This study focuses on the human behavioral, rather than the natural taphonomic aspects of fragmentation. Fragmentation is difficult to document, and its notation is almost always subjective. As there is no standard way of noting fragmentation, the following method has been used. In the database, the percent preserved of each bone in the assemblage was noted. This was done on a spectrum of 1 to 5, numbers describing the size of the preserved fragment in relation to the complete element it represents. Thus, a "5" describes a bone as 100% complete while a "1" describes it as less than 25% complete (see Appendix A for a complete description of these categories). Differences in the extent of bone fragmentation between taxa indicate how intensively a particular taxon was exploited for food. For example, a higher fragmentation would be seen if certain bones were habitually crushed for marrow extraction.

3.2.4.2 Cut marks

Butchery differs from fragmentation in that it refers only to human actions on bones. What we as zooarchaeologists observe from these actions is layer upon layer of butchery practices, which presumably result in a detectable pattern of human behaviors. Butchery encompasses human activities involved in the preparation of the animal carcass for consumption. Lyman's (1992:296) definition of butchery emphasizes human agency:

> "Butchering consists of a set or series of sets of human activities directed towards the extraction of consumable resources from a carcass. It has a temporal duration, made up of the set and order of activities carried out to extract resources from a carcass."

Lyman stresses the importance of including the word "human" in his definition of butchering "as the human reduction and modification of an animal carcass into consumable parts", where "consumable" refers to "all forms of use of carcass products, including but not restricted to consumption of products as food" (Lyman 1987:252). Aspects of butchery including skinning, de-fleshing, and dismembering are analyzed in this study by looking at the location and frequency of cut marks, articulating parts, and body part representation in the predominant taxa from all three sites.

Cut marks on archaeological bones can be seen as evidence for particular butchery practices. Cut marks made by humans are identified here by their location on the bone, their frequency, the direction of the mark, and how the direction reflects dismemberment techniques. They are distinguished from the parallel lines of rodent gnawing and the punctures or more random chewing striations made by carnivore teeth both in appearance and in location on the bone. Cut marks made by humans often result from mistakes due to carelessness or inexperience in butchery. It is presumed that if an individual is experienced at butchering a carcass, he or she will know just what areas to slice so they will not encounter bone. Any cut marks evident on bones can then be seen as the work of a hurried, careless, informal, or inexperienced person. Alternatively, a higher frequency of cut marks can reflect difficult in butchery, such as would result from attempting to disarticulate bones long after the death of the animal (in the case of dried meat, for example).

Cut marks can also be used to understand the way in which a carcass was processed into consumable parts. In this study, cut marks were noted when they were visible to the naked eye during laboratory analysis[16]. Two aspects of cut marks

[16] This method of identifying only superficial cut marks was necessary due to time constraints.

are used here to compare butchery practices between the three sites; the number of cut marks, and their location on the skeleton. In all cases, each specimen in the assemblage is counted as a single cut mark, even in the cases where elements are known to articulate. This is to get an idea of the most frequently cut areas of the carcass, and the most frequent type of cut mark.

### 3.3 Secondary production strategies

The previous section reviewed methods used to analyze the human consumption of primary animal products, particularly meat. This section details methods for assessing the human use of those products which can be taken from the animal without killing it. These types of animal products are called secondary products (Sherratt 1981) and include milk, wool/hair, dung, labor, and transport. Use of certain secondary products can sometimes be inferred through zooarchaeological analysis. Secondary products also comprise certain ideological or symbolic aspects of animal exploitation such as protection, companionship, and ritual. While these more symbolic facets of animal production are no doubt an major factor in peoples' lives, they are much less easily inferred from the zooarchaeological evidence. Because of the multi-faceted nature of secondary products, their use, and their symbolism, a major portion of this chapter is dedicated to describing the methods used to analyze the use of secondary products in the Chalcolithic and the Early Bronze IA and IB of the southern Levant. The first three methods described below detect indications of sheep/goat secondary products exploitation. While the majority of secondary products analysis involves kill-off patterns and herd composition, innovative research on bone thickness is also discussed. Other methods described below will investigate the use of cattle, including kill-off patterns, size, and pathological evidence for secondary products usage. The final method to be discussed will help determine the role of equids in the Chalcolithic and Early Bronze I southern Levant. These methods include size comparisons, species determination, and assessment of non-zooarchaeological evidence for equid exploitation.

### 3.3.1 Sheep/goat products

Since the advent of animal domestication, bones of sheep and goat more or less dominate the animal bone assemblages from southern Levantine sites (Grigson 1995b). The preponderance of sheep/goat bones in assemblages thus allows for more extensive (and reliable) secondary products analysis than other taxa whose bones are not so abundant. Analysis of secondary products in this study therefore focuses on sheep/goat in the hope that abundant samples of sheep/goat bones will provide reliable results.

#### 3.3.1.1 Sheep/goat mortality

Kill-off patterns are useful in determining the ways in which humans exploited their animals for food and other products. The same methods of bone fusion and mandibular tooth eruption and wear as detailed in section 3.2.3 are used to analyze secondary products exploitation through age data.

#### 3.3.1.2 Sheep/goat herd composition

Although sheep, in general, provide more meat than goats, goats are better adapted to an arid environment and have a higher reproductive capacity (Lancaster and Lancaster 1991; Zeder 1991). Ethnographic data show that, in the Sinai, Bedouin goats can be watered only every 2 to 4 days (Levy and Goldberg 1987). Sheep, on the other hand, are better adapted to wetter environmental conditions. In this respect, goats are lower-maintenance animals than sheep, who require more watering and better pasture. For these reasons, herd composition (specifically the ratio of sheep to goat) at a site can be said to reflect certain environmental conditions, such as aridity and availability of pasture. However, herd structure will also vary according to the motivations of the herder (Redding 1984). An analysis of the sheep/goat ratio thus acts as a barometer for both local environmental conditions and various human objectives in animal management. Methods for determining the sheep/goat ratio are used here to help distinguish the degree of human action in structuring herds in light of environmental conditions a particular region.

To determine the ratio of sheep to goat in a herd, it is necessary to confidently distinguish sheep bones from those of goat. These two caprines are notably difficult to distinguish. Boessneck's criteria for distinguishing the two taxa (and in some cases males from females) are widely used (Boessneck 1969). The suggested differences are predominantly visual, making the determination very subjective and less reliable than a metric distinction. While there is some agreement on which morphological differences can be reliably used to distinguish between sheep and goat, metrical distinctions tend to be more objective, and thus merit more credence. Metrical distinction can be made between sheep and goat distal metacarpi using a method described in Boessneck (1969). This simple method involves the measurement of the dorsal-palmar width of the trochlear condyle of the distal metacarpus, and dividing that measurement by the dorsal-palmar width of the verticillus (see Appendix B). A result of 0.63 or less indicates a goat, and greater than 0.63 indicates a sheep. This metrical distinction gives statistical support to a distinction that is visually notable: the verticillus of the distal metacarpus is larger in relation to the trochlear condyle in sheep than it is in goat. Distinctions between sheep and goat in this study were attempted on all sheep/goat bones; however, a bone was attributed to sheep or goat only when the distinction was especially clear according to criteria laid out in Boessneck (1969). Confident distinctions were made most often on the following elements (see Boessneck (1969) for descriptions of the distinguishing characteristics of each): distal humerus, proximal radius, innominate, proximal femur, metapodia, astragalus, calcaneus, phalanx 1, phalanx 2, and certain cranial elements (horn cores, occipital bone).

With a sufficient sample of sheep and goat isolated within an assemblage, the sheep/goat ratio can be assessed. In a study using both modern and archaeological sources, Redding defined models for different herding goals in the Middle East: energy off-take (calories); protein; and herd security, which he defines as "the minimization of fluctuations in herd size, particularly those that result in a reduction of annual yields" (Redding 1984). Herd security describes the balance between sustainability and productivity within the herd. Redding explains: "A flock of 50 sheep and 50 goats that suffers an outbreak of a species specific epizootic or parasite would lose, in the worst case 50 animals" (Redding 1984:227). His model is based on sheep and goat behavior, physiology, ecology, production and reproduction. He suggests that in a "good" environment, a herding strategy optimizing for energy or protein would have 20% goat, the sheep/goat ratio thus being 5:1. As the environment gets colder and wetter, an increase in sheep is expected, until the ratio is 1:0. Likewise, as the environment gets warmer and drier, an increase in the number of goats in herds is expected, until the ratio is 0:1[17]. For the goal of herd security, in a "good" environment Redding expects a sheep/goat ratio between 1.7:1 and 1:1[18]. The same effects of a warm/arid environment and a cold/wet environment noted for the goal of energy/protein also apply to herd security. Redding then applied his models of herding goals to three archaeological bone assemblages from southwest Iran. He found that, regardless of environmental differences and time period[19], the herding goal at these sites was always herd security. Redding therefore concludes that the goal of subsistence herding in this region of the ancient Middle East is herd security.

While Redding offers a useful model for investigating herding strategies, his model requires further testing, especially in light of his small sample sizes from some sites. For example, his sample from the Late Uruk at Farukhabad is only 17 total distinguished sheep and goat. Additionally, his 1984 publication never defines specific parameters for a "good" environment. However, he does define the environment of Tappeh Sarafabad as "good, with irrigated fields around the site and

[17] It must be noted that Redding's model also describes an increase in goat (towards 100%) as settlements become focused on agriculture, a model which is very similar to that for a goal of herd security in a warm, dry climate.
[18] Redding's growth simulation of Middle Eastern sheep and goats indicates that goat populations will increase at a greater rate than sheep. To allow for the slower growth rate of sheep flocks, the optimal sheep/goat ratio for herd security is between 1.7:1 and 1:1.
[19] The archaeological data Redding's discusses in this article are from deposits dating between ca. 6000 BC to ca. 3000 BC.

lush grazing available on nearby highlands during the winter and spring" (Redding 1984, citing Wright et al. 1980).

### 3.3.1.3 Radiographic analysis

In an attempt to find a less subjective means by which to determine milk use among archaeological sheep/goat populations, Horwitz and Smith developed a method involving measuring the thickness of the cortical wall of sheep and goat metapodia (Smith and Horwitz 1984; Horwitz and Smith 1991). A reduction in bone mass among ewes can be attributed to a number of factors, including poor pasturage, malnutrition, pregnancy and lactation, and intensive milking (Horwitz and Smith 1990). In the metapodia of sheep and goat, bone mass reduction can be seen in an increase in the size of the medullary cavity and a thinning of the cortical bone. The method used to radiograph sheep and goat metapodials involves placing the metapodials "with their anterior sides flat on the X-ray cassette, with the X-ray source at 1.0 meters using 40-45MV with exposure times varying from 1.5 to 2.5 minutes depending on the density of the bone" (Horwitz and Smith 1991). Using a light table, the Minimum Shaft Width (MSW) and the Medullary Cavity Width (MCW) of each bone is measured at the point of the narrowest breadth of the shaft. Measurements are taken twice and averaged. The Combined Cortical Thickness (CCT) is derived by

subtracting the Medullary Cavity Width from the Minimum Shaft Width (for a detailed description of this technique and accompanying figures, see Smith and Horwitz 1984; Horwitz and Smith 1991). Sheep and goat metapodia from archaeological sites in Israel and the West Bank showed a marked reduction in cortical thickness from the Chalcolithic to the Early Bronze Age, leading the analysts to conclude that intensive milking was practiced in the Early Bronze Age (Smith and Horwitz 1984). This evidence is especially convincing in light of suggestions that culling strategies for the Early Bronze Age show closer to 80% of the sheep/goat surviving into adulthood (Horwitz and Tchernov 1989). Further support for this was found using the same technique on metapodia from the Neolithic, Early Bronze Age, and Middle Bronze Age at Jericho (Horwitz and Smith 1991), where Horwitz and Smith found a slight decrease in cortical bone thickness between the Neolithic and the Bronze Age, and a significant decrease between the Early and Middle Bronze Ages. These findings are thought to reflect changing exploitation patterns over time and the intensive use of milk as a secondary product.

Potential complications with this method include problems with replicating the exact conditions for radiographing. Any number of factors can affect the results: the exposure time can be difficult to monitor; the measurement of smallest diameter of the shaft, even when taken three times and averaged, might seem arbitrary, especially on sheep metapodia, where the smallest diameter is difficult to determine due to the long shaft length. The preservation of the bones and the type of soil matrix in which they were deposited might also affect the preserved cortical thickness. Differences within the sheep/goat population at a given site might also complicate interpretation of the cortical thickness measurements. For example, a sheep/goat population from a lush environment might be larger or more robust in size than those from somewhere more arid like Jericho. While a size difference does not affect intra-population measurement comparisons, overall differences in size between populations might inhibit the comparison of samples from different sites. Sex will also affect the average cortical thickness. Grigson points out that Horwitz and Smith do not distinguish between males and females in their study. This distinction is important because, while a decrease solely among females over time can indicate milk exploitation, an decrease among both males and females might reflect environmental degradation over time (Grigson 1995b:257). Finally, the age of the individual sheep or goat will affect the cortical thickness. The metapodia fuse before the individual is fully grown, at 1.5 to 2.25 years (Silver 1969). Therefore, the fused metapodia used for a study of cortical thickness might be from individuals anywhere from 18 months to over 8 years old. As the thickness of the diaphysis wall increases with age (Bartosiewicz et al. 1997:106, referring to Kratochvil et al. 1988), this, rather than milking, could account for variations in cortical thickness. In spite of these potential complications, further bone mass studies among sheep and goat from this period will help substantiate this method.

### 3.3.2 Cattle products

#### 3.3.2.1 Cattle mortality

If cattle were being used for secondary products such as milk and draught, we would expect to see a significant number of animals surviving into adulthood and beyond. Tooth eruption and wear is a useful method for determining cattle age. There are too few cattle teeth in this study with which to construct informative mortality curves; therefore, kill-off patterns among cattle populations in this study are based on epiphysial fusion (following the method described in section 3.2.3.1). Unfortunately, there are only three age categories for cattle bones, and those categories provide information about cattle mortality only up to the age of maturity. To investigate cattle survivorship beyond this point, other lines of evidence are pursued: cattle size, pathologies that might be related to heavy labor, and non-zooarchaeological evidence for cattle secondary products.

#### 3.3.2.2 Cattle size

Size is an important factor when dealing with remains of domesticated cattle that might have been used for draught. The presence of oxen (castrated males) within an archaeological population is difficult to document, but oxen were likely a component of secondary products exploitation involving cattle. Bone growth in oxen will be affected from the time of castration onwards. However, to target the pattern of bone growth among castrates, the age of castration must be known. While measurements of male and female cattle bones might result in a bimodal graph, the castrates can fall anywhere within one group or the other, or somewhere in between. The Chalcolithic period is thought to have seen the first use of cattle for draught in this area (Grigson 1995b:267). The question of whether castrates were present at the sites analyzed in this study thus deserves attention. This study will use measurements on cattle bones for intra-assemblage comparisons of cattle size. The measurements are plotted in comparison to a known female *Bos primigenius* specimen from Denmark (method described in section 3.1.3).

3.3.2.3 Skeletal disorders on cattle bones

While a high proportion of adult cattle might indicate a degree of secondary products exploitation, more convincing data for *intensive* practice are found in skeletal disorders related to heavy labor, indicating the use of cattle for transport. Intensive use of cattle for draught/labor can result in numerous bone alterations, such as broadening and lipping of articular ends of bones from the carrying of excessive weight, and pitting and abrasions in the bone as a result of chronic foot infections (Bartosiewicz et al. 1997:33). Clutton-Brock (1979) found what she called a high proportion (7 out of 80) of pathological deformities on the phalanges of domestic cattle from Middle Bronze Age Jericho. However, she also found a pathological phalanx from a wild cattle (*Bos primigenius*) suggests that the pathologies on cattle bones might instead be related to a poor environment or to a rough or rocky topography (Clutton-Brock 1979). It must therefore be kept in mind that some pathological conditions might be a result of topography or the old age of the animal. This study notes pathologies through qualitative description of two features, the location of the pathology on the specific element, and a written description of the type of pathology present. In *Draught Cattle: Their Osteological Identification and History* Bartosiewicz, Van Neer, and Lentacker (1997) provide useful comparative photographs of pathologies on cattle foot bones.

### 3.3.3 Equid products

#### 3.3.3.1 Equid size and species distinction

Species distinction for equid bones is important to our interpretation of the way the ancient peoples of the southern Levant used wild and domestic equids. Four equid species were potentially present in this region during the Chalcolithic and Early Bronze Age: horse (*Equus caballus*), onager (*Equus hemionus*), wild ass (*Equus africanus*), and domestic donkey (*Equus asinus*). This study uses tooth enamel patterns and long bone size indices to aide in the determination of species. Tooth enamel patterns are often used to distinguishing *E. caballus* from *E. asinus/hemionus* (Bökönyi 1986; Davis 1980a). In the maxillary teeth of asses, the anterior and posterior sides of the protocone are of equal size, whereas in horses one is larger than the other. In the mandibular teeth of asses, there is no penetration of the buccal fold into the lingual fold, and the lingual fold is v-shaped rather than u-shaped (see Davis 1980).

In addition to distinctions by tooth enamel patterns, zooarchaeologists sometimes use bone measurements to assess equid size within a comparative index. Recent studies have found that post-cranial characteristics can be useful in distinguishing between equid species. For example, the bones of onager are thought to be slightly longer and thinner than those of ass (Davis 1980a:308). To determine the size of equids from Chalcolithic sites in the Northern Negev, Grigson uses a size index developed by Uerpmann. Size indexes are useful for comparing large numbers of measurements because they allow for the measurements to all be viewed on one graph. Grigson describes the formula and method as follows:

> "The formula used for calculating the size index (SI) of any particular dimension in an assemblage is:
>
> $$SI= ((a-X)/4s) \times 100$$
>
> where $a$ is the dimension of a particular element, $X$ is the mean of that dimension in the standard population, and $s$ is the standard deviation of that dimension. The indices are set out in ascending order of magnitude and plotted against the percentages of their cumulative frequency. In such plots the mean of the standard is at 0 and its theoretical range (X +- 2s) is at -50 and +50 on the index scale. The

mean of the indices for each sample can be read off on the X axis from where the line connecting the points crosses at the 50% level on the Y axis. A Gaussian, or normal, curve will be S-shaped" (Grigson 1993).

Using this formula, Grigson finds that size ranges from Chalcolithic equid bones fall into two groups, one within the range of domestic donkey and the other horse. Grigson concludes these must be the bones of domestic horses (*Equus caballus*) since there were no wild horses in this region during the Early Holocene[20]. These early finds of domestic horse are significant because they might indicate the use of spoked-wheeled vehicles or chariots as early as the Chalcolithic (Grigson 1993). To substantiate this hypothesis, Grigson refers to a horse metacarpal from Shiqmim with exostosis on the sides of the shaft toward the distal end (Grigson 1993). She speculates that this exostosis might be due to the animal's use for draft, although she clearly concedes that it could very well be a result simply of old age. Further data on equids from Chalcolithic and Early Bronze Age sites with substantial samples of equid remains will certainly lend more understanding to the issue of the origins and use of the domestic horse in the Near East.

3.3.3.2 Non-zooarchaeological evidence for the use of equids

In periods predating textual documentation of economic activities, zooarchaeological analyses are particularly important for understanding the nature of animal use. Where texts are available as a tool for assessing economic activity, it has been found that a contradiction sometimes exists between textual accounts of the animal economy and the archaeological evidence (Redding 1991; Zeder 1994). Contradicting evidence emphasizes the importance of tracing more than one line of evidence to a particular conclusion. While textual evidence is not available for the Chalcolithic or Early Bronze Age in the southern Levant, such artifacts as churns, figurines, and leather products can give some insight to the use of equids and other

[20] The claim that these bones come from domestic horse based solely on the geographical range of the wild horse has recently been criticized by Levine, who points to recent research indicating that the natural range of the wild horse extended further than was previously thought (Levine 1999).

animals at this time. Evidence from further afield, such as pictorial depictions of carts from Mesopotamia, will also be discussed.

## 3.4 Discard and distribution

While the two previous sections focused on methods of understanding how people managed their animals (whether they used them for primary or secondary products) this section deals with methodological issues concerning refuse. The underlying assumption here is that people will deal differently with food animals and non-food animals after they have died or have been killed. These differences in exploitation can then be detected in the zooarchaeological record. Distribution and discard activities (defined in Chapter 1, section 1.2.2.5) are difficult to assess because of the large number of taphonomic alterations to which animal bones are often susceptible. Zooarchaeological analyses involving spatial analysis require an understanding of the taphonomic factors affecting *which* bones are found and *where* they are found. From the time when the animal is killed, its carcass can be subjected to any number of human and non-human activities, such as butchery, breakage for marrow, cooking, tool-making, discard, dog gnawing, scavenging, and burial. It is important, then, to distinguish the factors that result from natural taphonomic factors from those that result from ancient human activities and modern human activities. Poor preservation is likely to affect the representation of elements in the archaeological assemblage. For example, the less dense portions of certain bones and unfused, juvenile bones are likely to be affected the most by an unfavorable preservation environment. Small bones, such as phalanges of sheep/goat and pigs, are dense and tend to preserve well, but are often overlooked by archaeologists. These possible biases are kept in mind throughout this study, and in particular when assessing the spatial layout of bones.

### 3.4.1 Intra-site species distribution

Spatial analysis involving animal bones has been attempted with varying degrees of success at a few sites from the Chalcolithic and Early Bronze Age (examples are given in section 2.1.1.1). This study undertakes spatial analysis both of species representation and of body part representation across each site. Specific regard to species stems from the idea that certain animals are commonly considered food animals, while others might be considered pets (such as dogs), or might carry a dietary or social taboo (such as pigs do among many Middle Eastern populations today). For example, what kinds of dietary and social implications might we interpret from an absence of pig bones at Shiqmim and a presence of pigs at the other two sites? It is presumed that potential societal attitudes towards different types of animals might be inferred through choice of disposal technique. The relative proportions of taxa are calculated within each locus, using the quantification method described in section 3.2.1. The spatial analyses in this study are generally limited to pits, floors, and fills ("fills" referring to any context of re-deposited material); that is, common features of all three sites. However, some discussion is made of tunnels, a feature characteristic of Shiqmim.

### 3.4.2 Intra-site body part representation

To assess the use and discard of various body parts, this study approaches body part representation in various loci on an intra-site level (a method similar to that for assessing inter-site species representation, described in the preceding section). An assessment of body part representation for all taxa shows which parts of which animals are preserved in the excavated area. This body part representation analysis is based on the assumption that ancient peoples discarded their food and other refuse near their homes, or near the village (and within the excavated area). Some of the more obvious differences in discard would, theoretically, be seen between the body part representation among bones of meat-providers and among those of animals that were not eaten.

In this analysis, body part representation analyses include all bones identified to taxon and to element. The one exception to this rule is the case of vertebrae and ribs. Throughout laboratory analysis, vertebrae and ribs were identified not to a specific taxon, but to a size class, such as "large mammal". For body part representation analysis, all vertebrae and ribs are divided up proportionally into the sheep/goat, cattle, pig, and equid categories. Other than this adjustment, all bone counts follow the standard quantification procedure described in section 3.2.1.

To analyze meat use, a breakdown of body parts within each taxon helps to show if certain parts are more common than others. Body parts are broken down into five skeletal areas that are thought to represent butchery techniques and distinction between meat-bearing and non-meaty portions (see Appendix A for a description of the five categories). A break-down by skeletal area can help tell us if the animal was being butchered on the site (in the area excavated), if certain parts were being used for food or tools, while others were discarded, or if some parts ended up in another location (perhaps another site or outside of the excavated area). It is presumed here that if elements are found to articulate within a deposit, then they were discarded together, probably while still articulated. This means that they were probably primary discard from the butchering process. On the other hand, highly fragmented meat-bearing bones might indicate secondary, or post-consumption, discard rather than primary butchery discard. An analysis of which body parts were used, and which were thrown away at different sites might say something about the different ways populations exploited their meat providers.

One problem with body part representation assessment is the problem of differential bone count. To account for the fact that sheep have eight first phalanges and only two humeri, or that a pig has more hand and foot bones than a sheep, some analysts adjust the data accordingly. This study prefers to use raw data based on NISP bone counts when calculating body part representation. This decision was made for a number of reasons: 1) the data come from three sites with different retrieval strategies and excavation goals; 2) some of the sites were excavated over many numerous seasons with changing teams of excavators; 3) two of the excavations were field schools while the third was excavated by only professional archaeologists; and 4) the sites are located in different environmental areas with different soil chemistry. All of these factors contribute to differential preservation and retrieval, elements which can obscure the results of analysis. It was decided that adjusting the data would only further obscure the results and that a straight-forward NISP count would be the clearest way to present the data. However, to demonstrate the amount of variability encountered given the different approaches, adjusted bone counts have also been included in this study. Adjustments were made according to the number of times a particular element occurs in the skeleton of each species (see Tables 36a-36e). An example of the variation in this method that can lead to confusion is found in the method for adjusting the data: the astragalus and the calcaneus, both tarsal bones, are identified to element and are therefore divided by two when the adjustment is made. However, the other tarsal bones are identified as "other tarsal", not to a specific name, and so are divided by six when the adjustment is made. The other tarsals are therefore likely underrepresented in the adjusted data. The same holds for vertebrae, where some people distinguish between the seven cervical vertebrae, for example, and others lump them all together. To avoid confusion regarding the results of body part representation, this study presents both the raw data and the resulting adjusted data, together with the numbers chosen by which to make the adjustment (see Tables 36a-36e).

# Chapter 4

# Materials for Analysis

Three animal bone assemblages were chosen to address the research questions posed in Chapter 2 regarding social change in Chalcolithic and Early Bronze Age of the southern Levant. Zooarchaeological methods described in the previous chapter will be applied to the three assemblages in an attempt to understand the role of the subsistence economy in light of social change. In this chapter, I first describe the reference materials and recording procedures that I used for laboratory analysis of the animal bones (section 4.1 and 4.2). I then describe the chronology, location, excavation, and animal bone assemblages from each of the three sites considered in this study (section 4.3). Finally, in section 4.4. I discuss the suitability of the three aforementioned assemblages to investigating the primary research themes regarding the Chalcolithic-Early Bronze I transition.

## 4.1 Reference materials

Laboratory research was carried out at the Zooarchaeology Laboratory of the Hebrew University of Jerusalem, where the animal bone assemblages from all three sites are stored. The Zooarchaeology Laboratory is supervised by Professor Eitan Tchernov of the department of Evolution, Systematics and Ecology at the Hebrew University of Jerusalem.

The Zooarchaeology Laboratory contains specimens of the entire corpus of taxa represented by the Shiqmim, Afridar, and the Halif Terrace assemblages. Morphological comparisons were possible in all cases, often with numerous individuals of each taxon. The relevant specimens were all locally procured, and included both modern and archaeological individuals. Due to the problem of size variation between regions and between modern and ancient populations, size comparisons are made only with published archaeological populations, rather than with laboratory specimens.

The animal bone reference collection took precedence in the identification process. However, where clarification was needed, a number of manuals served as complimentary materials for identification. Laboratory identifications for this study were aided primarily by Schmid's (1972) *Atlas of Animal Bones*. Other identification manuals that facilitated inter-species comparison are Hillson's (1992) *Mammal Bones and Teeth* and Barone's (1976) *Anatomie Comparée des Mammifères Domestique*. Distinctions between sheep and goat were aided by the studies of Boessneck (1969) and Prummel and Frisch (1986). Distinctions between equid species were based largely on drawings and accompanying text in Davis' work on ancient equids from Israel (Davis 1980a), as well as methods detailed in Grigson (1993). Measurements, except where otherwise specified, follow von den Driesch's (1976) *Guide to the Measurement of Animal Bones from Archaeological Sites*. Details of measurements used in this study are given in Appendix B.

### 4.2 Recording procedures

Each bone was initially identified to either a taxon or a size category. In this study, an "identified" bone is one which can be specifically identified to element and taxon. Bones not determined to element or taxon were separated into size groupings of less than 5cm and greater than 5cm, counted, and noted in the database as "unidentified". Due to time constraints, these indeterminate fragments were not weighed, and were not separated into size categories (such as small, medium, and large mammal) or into body area (such as long bone and cranium fragments). Bones which could be identified at least to element (and ideally to taxon) were subject to up to 25 criteria of assessment. Laboratory analyses focused on the basic variables of zooarchaeological identification, with any unusual features being noted. Each bone was given an identification number and entered into an Excel spreadsheet, where the following characteristics were recorded: species, element, fragment size, side, fusion data, age data, sex, evidence of burning, cut marks, measurements, and contextual data including locus number, basket number, context description, volume and stratum. All measurements were taken in millimeters using Vernier calipers (to 1/10 of a millimeter). The bones were individually numbered in the spreadsheet, but numbers were not written on the bones due to time constraints. After analysis, each group of bones was returned to its original packaging, and the identification numbers of the bones contained within were noted on the outside. A sample of the Excel spreadsheet used, as well as a detailed description of the criteria used for assessment can be found in Appendix A.

This study uses a broad range of measurements, primarily to facilitate intra- and inter-assemblage comparisons, specifically regarding size and sex. The number of measurements possible to take on a bone fragment will depend on which parts are present. In this study, up to 8 measurements for each bone were taken: the maximum number of measurements (8) would therefore be from a complete bone, and the minimum (1) from a small bone fragment with two measurable points present. Measurements on teeth include crown height for equids, taken on the lingual and buccal sides of the tooth, as well as greatest breadth (GB) by greatest width (GW) of the occlusal surface of the tooth. A list of the range of measurements used for each element in this study is given in Appendix B.

### 4.3 Zooarchaeological materials

The animal bone assemblages which make up the basis of this study come from three southern Levantine sites in the northern Negev desert /southern coastal plain area of Israel (Illustration 2). The three sites, all located within a 55km range of each other, together span the Late Chalcolithic through the Early Bronze IB. In all discussions of the animal bone analyses through this study, the sites are considered in the following order: Shiqmim, Afridar, and the Halif Terrace. This order is chronological and facilitates discussion of change over time: the animal bone assemblage from Shiqmim comes from Chalcolithic deposits; that from Afridar comes from early EB IA deposits; and, the assemblage from the Halif Terrace comes from EB IA and early and late EB IB deposits. These sites are chosen for this study for three reasons. First, they each provide a reasonably-sized assemblage of animal bone for inter-site comparisons. Secondly, they have occupations specific to a particular cultural phase (with the exception of the Halif Terrace, which spans both the Chalcolithic and the Early Bronze Age[21]). It is hoped that this limited occupation will aid in the distinction of specific animal-related activities which can be associated with a specific site or time period. Finally, the sites are within close proximity to each other, allowing for comparisons within a well-defined region. This section describes the background of each of the three sites, including location, lay-out, chronology, and other distinguishing characteristics.

### 4.3.1 Shiqmim (4500-3700BCE)

#### 4.3.1.1 Location and environment

Shiqmim is located on the northern edge of the Negev desert in what is today southern Israel (see Illustrations 2 and 3). The site is approximately 18 kilometers west of Beersheva. It lies along the northern bank of the Wadi Beersheva in an area which has been found to contain a rich Chalcolithic heritage (Levy and Alon 1987b). The environment of the northern Negev desert is similar to but drier than that of the Mediterranean coastal zone and the Negev foothill zone, where Afridar and the Halif Terrace lie, respectively. The area around the Wadi Beersheva is hot and dry during the summer, with relatively wet winters, but only about 200 mm of rainfall per year and less than 60% humidity (Levy and Goldberg 1987:10).

#### 4.3.1.2 Site lay-out and chronology

The ancient settlement at Shiqmim was a large village inhabited during the

[21] Only the Early Bronze IA and IB faunal material is considered in this study. The Chalcolithic faunal material is being analyzed by Dr. Caroline Grigson. Upon completion of their analysis, the Early Bronze I and Chalcolithic will be brought together in a future publication.

Chalcolithic period. Shiqmim is one of the largest of the many settlements which make up the Ghassulian Chalcolithic settlement in the Beersheva basin. The site is characterized by rectilinear rooms, subterranean and semi-subterranean rooms, and numerous pits. The ceramic assemblage includes common Chalcolithic forms of the Beersheva area, among which are v-shape bowls, cornets, churns, and holemouth jars (Levy and Alon 1987a). The Ghassulian Chalcolithic phenomenon is known for its complex and unique nature, reflected in settlement size, religious or cultic architecture, and extraordinary pottery and art forms (the Beersheva ivories, painted ossuaries, anthropomorphic and zoomorphic figurines, to name a few). Owing to its vast corpus of artifacts and architectural features, Shiqmim can been seen as an archetype of the Chalcolithic phenomenon in the southern Levant.

More specifically, the 1993 excavation season considered in this study involved work in Area D in the west part of the main village and Area X in the east portion of the settlement. An expansion in Area D involved a clarification of the system of sub- and semi-subterranean rooms which characterize this site and other Chalcolithic sites in the Beersheva basin (Perrot 1984). Work in Area X revealed subterranean complexes in that area as well, demonstrating the extensive use of these structures, which are interpreted as storage areas, across a large area of the site (Levy et al. 1996). Radiocarbon dates obtained from charcoal samples from previous excavations (pre-1993) at Shiqmim date the site to the mid-5$^{th}$ to mid-4$^{th}$ millennium BCE (Carmi and Segal 1992; Levy 1992a) (see also Joffe and Dessel (1995) for a list of radiocarbon dates from Shiqmim). The latest dated sample from a burial pit in building phase I of the main village at Shiqmim falls at 3700 BCE, placing the final settlement of Shiqmim on the cusp of the Late Developed and the Terminal Chalcolithic sub-phases (Joffe and Dessel 1995).

#### 4.3.1.3 Excavation and animal bone assemblage

Excavations at Shiqmim were carried out for eight seasons, beginning in 1979. As mentioned above, the bones included in this study come exclusively from the

1993 excavation season at Shiqmim. The 1993 excavations at Shiqmim were co-directed by Thomas Levy and David Alon under the auspices of the University of California, San Diego and the Hebrew Union College, Jerusalem. The excavation was a field school for undergraduate students from the University of California and non-student volunteers. Animal bones were hand-picked by the excavators. Every locus and basket which produced animal bones received a unique paper bag for collection and storage. Dry-sieving with a _ inch mesh was undertaken on all pits and cultural layers (Thomas Levy, personal communication). The recovered animal bones were stored in facilities at the Hebrew University of Jerusalem for two years before undergoing analysis. The entire corpus of animal bone recovered was analyzed during the summer of 1995 by myself. The total number of identified specimens is 1558.

#### 4.3.1.4 Limitations of the material

Zooarchaeological material from Shiqmim is well-preserved with little to no accretion of matrix on the bones. This ideal situation is due in part to the dry climate, and probably also to the numerous pits at the site which protect the bone material in them from trampling or disturbance. One predicament during analysis was a time limitation which prevented me from counting and sorting the bones which I deemed unidentifiable. This constraint limits fragmentation studies on the Shiqmim material.

### 4.3.2 Afridar (3600-3300BCE)

The animal bone material from Afridar comes from three distinct adjacent sub-sites within the Afridar area. Throughout this analysis, these sub-sites are referred to as Area E, Area F, and Area G. The three areas all fall within the very early EB IA, with small amounts of older material attributed to the Chalcolithic or the Neolithic. All areas appear to have had short (ca. 50-100 year) occupations. Wherever possible, the three areas of Afridar are considered independently of each other throughout this study. However, the small size of the animal bone assemblages from Areas E and F is not adequate for some analyses included in this study. In cases where a larger sample size is needed for interpretation, the material from Area G, by far the largest of the areas, is used exclusively for the analysis.

4.3.2.1 Location and environment

Afridar is located in the southern portion of the Mediterranean coastal zone of what is present-day Israel (see Illustrations 2 and 3). This area is characterized by numerous *kurkar*[22] ridges. It lies ca. 2 kilometers north of Tel Ashkelon. As mentioned above, human occupation at the small settlements of Afridar in the Early Bronze IA was short-lived (ca. 50-100 years).

In contrast to the northern Negev, the coastal plain is more humid, receiving up to 400 mm of rainfall on average per year (Levy and Goldberg 1987:10). The area is inhabited by predominantly Mediterranean-type species of plants and animals, with some similarity to the environments of the northern desert edge/southern Shephelah, giving it an environment more similar to that of the Halif Terrace than that of Shiqmim.

4.3.2.2 Site lay-out and chronology

4.3.2.2.1 Area E

Of the three adjacent areas of Afridar in this study, Area E lies nearest to the ocean. The site runs along a *kurkar* ridge parallel to the coastline for about 100 meters (Golani 1997). Two areas (A and B) were excavated. Both areas produced large numbers of pits, the finds within which all date to the EB IA. Area A had up to 90 pits of various shapes and cuts (ranging from a diameter of 0.5 meters to 2.4 meters, and a depth of 0.15 meters to 2 meters) (Golani 1997). The pits, thought to have once been used for storage, but later filled with rubbish, are thought to date to the EB IA. Area A also produced a partial burial of a dog, with its head lying on a

[22] *Kurkar* is the local word for cemented, calcareous sandstones (Goldberg 1995:49)

donkey limb bone. Area B had fewer pits than Area A, and produced what is thought to be remains of metal-working associated with bowl-shaped installations (Golani 1997), interpreted as such because of metal slag and fragments of crucibles found in association with these installations. Although both areas have activity-related features, neither area produced any structures which can be said to be human dwellings. This makes Area E a very interesting area because it is a unique activity area. It might show some interesting differences from the other two areas, F and G, which do have architecture.

Ten radiocarbon dates were taken from solid stratigraphical pit fill contexts at Afridar E. Two of the radiocarbon samples came from charred olive wood, four from charred olive stones, and another four from unidentified charcoal. The dates all cluster around the first half of the fourth millennium BCE, from ca. 4000-3500 BCE (Amir Golani, personal communication). While the material excavated in Area E is Early Bronze I in nature, the early dates seem to indicate that the site falls within the Chalcolithic. Either that, or the radiocarbon dates from this site push the Early Bronze Age back a few hundred years. This is unlikely, especially in light the dozens of pits at the site. In light of the Neolithic flint finds in Area G, and other evidence for a Late Neolithic occupation in the area (Perrot and Gopher 1996), it is possible that the excavation of these pits in the Early Bronze Age dug into earlier cultural material, the dating of which has pushed the dates back to an earlier period. It therefore seems that the typology of the ceramics is at present the most reliable evidence for attributing the site to the Early Bronze Age. It is hoped that further analysis of the nature of the deposits which produced the radiocarbon dates, as well as additional dates from Areas F and G, will shed light on this problem.

#### 4.3.2.2.2 Area F

Excavations in Area F, the smallest of the excavated areas, exposed three distinct strata. Stratum I produced a number of curvilinear structures with preserved floors on which intact pottery vessels were found. One building (Building 2) had two phases represented: the first a wall of two rows of small stones with mudbrick sandwiched between them, and a second phase of large stones only. A compact floor and a stone hearth were also found in this building. Stratum II represents an intermediate phase between the two distinct Strata I and III. It consisted of ash and pottery fragments, and only one distinct feature, a portion of a mudbrick wall. Beneath this, Stratum III comprises numerous conical and bell-shaped pits, within which were found bones and fragments of V-shaped bowls. Stratum III dates either to the Late Chalcolithic, or perhaps to the very early portion of the EB I (Khalaily and Wallach 1998 in press). Area F, thus, appears to have had at least three building phases, and at least one distinct hiatus in occupation. The most recent building phase comprises a more permanent building structure (with stone, rather than mud brick walls), a feature also noted in Area G (see below). Charcoal samples taken from the floors of the two buildings produced radiocarbon dates of 3372 and 3043 BCE.

#### 4.3.2.2.3 Area G

Of the three areas of Afridar considered in this study, Area G produced the largest animal bone assemblage. The cultural material in Area G is typologically dated to the earliest phase of the Early Bronze I, to the "very brink of the Chalcolithic horizon" (Eliot Braun, personal communication). The two buildings in Stratum I, buildings G-1/1 and G-1/2, have stone foundations with mud brick superstructures, and are circular and curvilinear in shape, respectively. Packed earthen floors were detected both within and outside these buildings. In Stratum I was also found an earlier phase of the curvilinear building G-1/2. This earlier phase is completely mud brick, and also has an earthen floor associated with it. Apparently the mudbrick structures did not hold up well in the coastal environment, and stones were used later on to provide a more stable structure (this modification is seen in Area F as well).

Stratum II of Area G produced a number of mud brick walls which, though poorly preserved, appear to have made up a number of curvilinear buildings. Ceramic styles at Area G show a combination of Chalcolithic and Early Bronze I features. Based on this medley of styles, Strata I and II are attributed to the very initial stages of the Early Bronze I, or what might be called a transitional stage between the Chalcolithic and the Early Bronze I. The two strata are distinguished by two building phases identified by their construction techniques (in the earlier phase mud brick was used exclusively, while stone foundations were laid for the buildings of the later phase). However, the two strata share the same mixture of EB I and Chalcolithic elements: both contain architecture, groundstone, and *some* ceramics that are characteristically EB I, but the majority of the ceramics are made in a tradition derived from the Chalcolithic (Eliot Braun, personal communication). Braun suggests that, based on the bricks' standard size and sharp 90º angles, they appear to have been form made (Eliot Braun, personal communication). Below Stratum II, Stratum -II consists of a small area of tightly compacted floors. The material cultural remains found here are a mixture of artifacts that can be attributed to either the EB I or the Chalcolithic. Another sounding, near bedrock, contained flints associated with the pottery Neolithic (Eliot Braun, personal communication).

One of the more interesting aspects of this excavation is the overlapping of styles and traditions between the Late Chalcolithic and the Early Bronze Age (Eliot Braun, personal communication). However, Braun interprets some of the Chalcolithic elements here as residual, or heirlooms, and emphasizes that this site does not represent a direct continuation of settlement from the Chalcolithic Beersheva sites. Nor does it represent any overlapping of the Chalcolithic and Early Bronze Age, in spite of some evident cultural continuity.

4.3.2.3 Excavation and animal bone assemblage

All areas of Afridar were salvage excavations undertaken by the Israel Antiquities Authority to make way for urban development. Following excavations, the recovered animal bones from all three sites were stored at Israel Antiquities Authority facilities in Jerusalem while they awaited analysis. From 1996-1997, I undertook analysis of the entire corpus of animal bones recovered from all three areas.

Area E was excavated by Amir Golani during August-September of 1994, and February-May of 1995. Animal bones were collected in a separate bone bag for every context in which they were present. In secure contexts, such as pit fills, the matrix was also sieved in order to recover smaller animal remains. While the percentage of sieving varied (up to 50%), an average of 25% of all relevant contexts was sieved (Amir Golani, personal communication). Excavations in Area E recovered 2189 bones and bone fragments. Of these, 732 bones were identified to taxon and element. However, a portion of these 732 bones was taken from topsoil loci, and are therefore ignored here, leaving 527 bones to be included in this study. A compact matrix covering the bones caused many of the bones to be broken during excavation. Modern breaks on elements which could be identified were glued back together. Unidentified fragments were not refitted, but were grouped together and counted only once in the fragment counts. The high salinity of the soil made it impossible to clean the bones in water, as water caused them to disintegrate. Instead, the material had to be cleaned off slowly with a wooden pick and a wet brush. Some bones, even after cleaning, were encrusted with patches of calcium carbonate, making the notation of butchery, gnawing, or other bone-processing marks difficult.

Area F was a salvage excavation directed by Hamudi Khalaily and Zvi Wallach, of the Israel Antiquities Authority, during December 1994 and January 1995. All material from living floors and pits from layer II was dry sieved, and the animal bones were collected in paper bags and were not washed (Hamoudi Khalaily, personal communication). Area F produced 1071 bone specimens, 303 of which were identified to taxon. The soil conditions in Area F were like those in Area E, and so the bones were similarly corroded. The same laborious cleaning technique used for the Area E bones was used for the Area F bones.

Area G produced the largest volume of animal bones of the three areas: 10,479 in total, 3277 of which were identified to taxon. Salvage excavations in Area G were conducted by Dr. Eliot Braun of the Israel Antiquities Authority in the spring of 1993. The fill in which occupational remains were found is a dark-brown, water-retentive soil. It's dampness and high salt content was damaging not only to pottery (Braun, unpublished Afridar excavation report), but to the animal bones as well (as described above). Fortunately, the animal bones from Area G proved slightly more durable than those from Areas E and F, and could withstand washing without disintegrating.

#### 4.3.2.4 Limitations of the material

The animal bone assemblages from the three Afridar areas have a number of problematic issues. The first is that these were salvage excavations, undertaken to pave the way for a building project. The excavations did not then have the same kind of time leeway as a field school, such as Shiqmim and the Halif Terrace. We might then expect certain biases to appear in the assemblage from a salvage excavation where smaller bones and bone fragments might be more frequently overlooked than in a field school. One such bias would be the impression that there are more adult animals because of the disintegration or overlooking of deciduous teeth or unfused bones. Another bias of this type of recovery might be the perception that certain skeletal areas are not present at the site, indicating human choice, when in actuality small foot bones are missing from the assemblage due to salvage recovery.

Another problem with the Afridar faunal material is the nature of the soil, which has been described above. The site's proximity to the sea meant that the earth proved to be a salty matrix, causing a weakening of the bone structure, especially when exposed to water, making cleaning an extremely fragile and difficult process. Additionally, the frequent calcite build-up clinging to the bones sometimes obscured identification.

A final problem is perhaps the most detrimental to our interpretation of animal-related economic practices specific to the EB IA at this site. As discussed above, radiocarbon dates from these three sites have shown a serious discrepancy between the expected dates and the resulting dates. Area E seems to be the most problematic, owing to the fact that most of the material comes from pits. The dated materials, then, are from the fill of these pits, so we would normally expect them to be from a later period than that in which the pits were cut. While the majority of the cultural material in Area E can be attributed to the EB IA, the radiocarbon dates from the site come out in the first half of the 4$^{th}$ millennium, which would place the site in the Late Chalcolithic. It is possible that the dates taken on olive wood came from a long-lived tree, which would push the date back a few hundred years. However, the dates on olive stones should be contemporary with the occupation of the site. Perhaps some of the pits cut into older material cultural levels. As discussions regarding the radiocarbon dates from Afridar continue, the present study analyzes the animal bones as a whole, within the greater context of EB IA Afridar (including Areas F and G). Special emphasis is given to certain outstanding contexts (bone concentrations, for example), but chronologically-dependent conclusions are avoided until further consensus is reached regarding the dating of the site.

### 4.3.3 The Halif Terrace (3600-3000BCE)

#### 4.3.3.1 Location and environment

The Halif Terrace is located on the interface between the Irano-Turanian semi-arid and the Mediterranean environmental zones of the Negev and Shephelah (see Illustrations 2 and 3) (Levy et al. 1997). The Halif Terrace is named after a small, seasonal drainage which flows west into the Nahal Grar/Nahal Patish, and out to the Nahal Besor, where it meets the Mediterranean Sea. The zone in which the Halif Terrace lies receives about 400 mm of rainfall a year. The site also lies on an important ancient trade route east-west from the Mediterranean coast, and north-south from the hill country to the northern Negev (Levy et al. 1997:3).

4.3.3.2 Site lay-out and chronology

The majority of the excavated area at the Halif Terrace can be attributed to the EB IB; however, there is a modest Chalcolithic and EB IA (post-Chalcolithic collapse) component to the site as well. Excavations at the Halif Terrace included the Chalcolithic area of Abu Hof and a large, open-air excavation on the Halif Terrace, a largely Early Bronze Age area with a small amount of Chalcolithic. For the purpose of this study, the Halif Terrace is used as a representative for the EB IB; however, some conclusions will be drawn in reference to the EB IA material as well. In the final occupation of the Halif Terrace (Stratum IIa and IIb, representing the late EB IB), the ceramic assemblage is characterized by both Egyptian-style and Canaanite-style forms (Levy et al. 1997). This has led the excavators to believe that there might have been a local Egyptian population living alongside, or intermingling with, the Canaanite population (Kansa and Levy 1998). This study concerns animal bone remains from the EB IA through the EB IB (Strata II and III). Stratum IV, the Chalcolithic phase, will not be considered here (see footnote 15).

Briefly, some aspects of the Early Bronze Age phases from the Halif Terrace are as follows. Stratum IIIb represents the post-collapse EB IA at the Halif Terrace. There is not much in the way of architecture from this phase. Numerous pits and a semi-subterranean structure indicate a "looser organization of space and architecture than is characteristic of EB IB and the Chalcolithic period in the northern Negev" (Levy and Alon 1997). The EB IA phase provides a relatively crude ceramic assemblage compared with the rest of the site. There are few regular forms, and a general crudeness to the quality of the EB IA ceramics. This is taken to possibly indicate a break-down in this post-Chalcolithic collapse period of the highly defined social and political boundaries seen in the Chalcolithic (Levy et al. 1997).

The subsequent EB IB period is the most largely represented phase from the excavated area at the Halif Terrace. It is also the phase in which Egyptian pottery becomes prevalent (Levy et al. 1997). Stratum IIIa encompasses the early part of the

EB IB. The ceramics from this period seem to indicate an increase in storage vessels, possibly corresponding to the changing economic priorities (for example, a build-up of surplus). Remains from the late EB IB (stratum IIb) were found most frequently in Areas C and D. Finds in Area D include a small series of rooms associated with bread production (evidenced by a large number of Egyptian-style bread molds and a tabun, or oven). The late EB IB in Area C (strata IIa-IIc) is represented by extensive stone architecture, some of which is thought to be public in nature (Levy et al. 1997). Examples of architecture from this phase include stone walls and rooms, a stone-lined silo, and a larger circular installation of unknown function (perhaps a large silo) (Levy and Alon 1997). The large amounts of Egyptian-style ceramics, both local and imported, numerous finished and unfinished maceheads, a *serekh*[23] of Narmer, and an Egyptian seal impression, among other finds, point to the extraordinary nature of this phase.

4.3.3.3 Excavation and animal bone assemblage

Excavations at the Halif Terrace were part of the joint University of California, San Diego / Hebrew Union College Nahal Tillah Regional Archaeological Research Project that took place during three summers, from 1994-1996. The project was a field school co-directed by Thomas E. Levy of UCSD and David Alon of HUC. The animal bone assemblage included in this study is entirely the work of Caroline Grigson who was, until recently, the principal zooarchaeologist for the Halif Terrace. Dr. Grigson has analyzed the first two seasons' material. She will continue to work on the corpus of Chalcolithic bones, while I will analyze animal bones recovered from Early Bronze Age levels during the third and final (1996) season. For this study, however, the Early Bronze Age data under discussion are the work of Dr. Grigson, and are used here with much appreciation.

Animal bones from the Halif Terrace were collected separately from human

[23] A *serekh* is an Egyptian design made up of a schematic representation of a temple facade, above which is inscribed a king's name (Ben-Tor 1992:94).

bones, in paper bags by locus and basket. Dry-sieving (1/4 inch mesh) was carried out on all pits and cultural layers (Thomas Levy, personal communication). The Early Bronze IA and IB contexts considered here span a period from ca. 3600-3000 BCE. This study includes all the Early Bronze Age bones from the 1994 excavations, and all but Area C from the 1995 season. The total number of identified bones from non-topsoil loci is 1910, allocated as follows: EB IA: 325; early EB IB: 191; late EB IB: 1117; mixed EB IB: 277. In order to keep the phases clearly distinguished, the 277 bones from mixed EB IB loci are not considered in this study.

#### 4.3.3.4 Limitations of the material

The animal bone assemblage from the Halif Terrace is potentially problematic because of discrepancies in methodologies given two different analysts. However, because I worked closely with Dr. Grigson on the Shiqmim animal bones, my familiarity with her methods of analysis greatly facilitated my looking at her work. We followed a similar analytical design, which tended to minimize any potential interpretation issues.

## 4.4 Pertinence of zooarchaeological materials

This study investigates the nature of the subsistence economy in the Chalcolithic-Early Bronze Age transition. A site with animal bone material spanning the late phase of the Chalcolithic and the earliest phase of the Early Bronze Age would be ideal. However, due to the large-scale abandonment of Chalcolithic sites at the end of the Chalcolithic period, sites with both Chalcolithic and EB I material are very few. The next option would be to compare sites in close proximity to each other, from the Late Chalcolithic and the Early Bronze I, which have relatively large faunal assemblages. The presumption would be that these sites were inhabited in subsequent periods, and perhaps even overlapped by some years. The present study meets these criteria. The three sites are from the Chalcolithic, the Early Bronze IA, and the Early Bronze IB. While Shiqmim has provided radiocarbon dates that fall into the latest Chalcolithic in the area, Afridar probably represents the earliest manifestation of the EB IA in the region. The assemblages from the Halif Terrace contain deposits from both the EB IA and the EB IB. This will provide an interesting comparative overlap with the EB IA at Afridar. All three sites are within 80 km of each other. Their animal bone assemblages total over 7300 bones identified to both taxon and element within reliable Chalcolithic or Early Bronze I contexts. The three sites are therefore useful candidates for a regional study of animal economy during the Chalcolithic to Early Bronze Age transition.

# Chapter 5

## Analytical Results: Animal Use at Shiqmim, Afridar, and the Halif Terrace

Chapter 3 reviewed methods for zooarchaeological analysis of faunal remains from Chalcolithic and Early Bronze Age sites. Animal bones for this study come from three sites in the southern Levant, described in Chapter 4. Shiqmim is a Chalcolithic (ca. 4500-3700 BCE) settlement situated on the northern edge of the Negev desert. Afridar is an early EB IA (ca. 3600-3300 BCE) site on the Mediterranean coastal plain. Finally, occupation at the Halif Terrace spans the Chalcolithic through the EB IB. Animal bones used in this study from the Halif Terrace come from EB IA and EB IB contexts (ca. 3600-3000 BCE). The methods described in Chapter 3 were applied to the animal bone assemblages from these three sites, with the aim of obtaining information both about the local environment and human activities pertaining to animals. Results of these analyses are presented below in four sections. Section 5.1, "The environmental setting", describes characteristics within the faunal bone assemblages that reflect human exploitation of animal products within certain environmental constraints and options at each site. With an understanding of the limitations of the environmental settings at each site, "Primary products" (section 5.2) presents results of analyses pertaining to human use of primary animal products, specifically meat. Section 5.3, "Secondary products", investigates evidence for the use of animals beyond meat, for products such as milk, wool, and labor. Finally, "Distribution and discard" (section 5.4) investigates variations in the spatial distribution of the taxa and body parts in the three assemblages.

## 5.1 The environmental setting

The procurement by humans of food and other animal products is a leading factor in the formation of the zooarchaeological record. These human behaviors occur within certain limitations and options, some of which are posed by the local environment. A clear understanding of the environmental limitations in the formation of the zooarchaeological record is needed in order to more clearly interpret human activities within the zooarchaeological record. This section, therefore, addresses the constraints and potentials of the local environment at each site. This is done using the faunal spectrum (defined below), animal size, and pathologies related to environmental condition.

### 5.1.1 The faunal spectrum

The term "faunal spectrum" in this study refers to the range of animals present in the excavated archaeological assemblage. Methods described in section 3.1.1 are used to determine the amount of variability within each assemblage. The faunal spectrum for each assemblage will be defined by the species richness and by a comparison of taxa present at each site.

#### 5.1.1.1 Taxonomic richness

Taxonomic richness describes the diversity with an assemblage, comparing the number of different taxa within an assemblage with the number of individuals per taxon[24]. Table 1 presents the results when the formula described in section 3.1.1.1 is applied to the assemblages from Shiqmim, Afridar, and the Halif Terrace. The richness, or diversity of taxa within an assemblage can be seen as a general indicator of the natural and social environment (the location of the site and the motivations of the people living at the site). For example, Shiqmim is located in the northern Negev desert where the inhabitants would not have had access to quite as diverse an environment as that of Afridar, located on the coast. As expected, even the smallest assemblage from Afridar (that from Area F, with 303 identified specimens) shows a much higher taxonomic richness than that of Shiqmim whose assemblage has five times more bones than Area F. It therefore seems likely that the people of Shiqmim did not have access to, or chose not to exploit, such a diverse selection of wild or domestic fauna as was available to the inhabitants of Afridar and the Halif Terrace.

There appears to be a decrease in taxonomic richness at the Halif Terrace over time, from the EB IA to the EB IB. This decrease might represent a depletion of the local animal resources with long-term occupation of the settlement. It might also reflect more specialized economic activity, focusing on a narrower range of animals. Interestingly, this decrease in taxonomic richness corresponds to an increase in the relative proportion of sheep to goat over time (see Table 30). These results as they pertain to human activities will be discussed further in the next chapter.

Of the three sites in question, Afridar Area G has the "richest" or most diverse range of taxa present in the assemblage (Table 1). To a certain point, the number of different taxa will increase along with the size of the animal bone assemblage. A very large assemblage will certainly represent the commonly exploited animals, as well as most of the rarer taxa. As the sample becomes larger, the number of new taxa found will eventually drop-off. To estimate where the upper limit for new taxa might fall in a large assemblage, Figure 1 shows the total number of different taxa per every 500 identified bones at Afridar G (identified in no specific order). The graph indicates that there is an average of 10 different taxa in every group of 500 bones. The number of new taxa per 500 bones increases dramatically in the first three increments, up to about 1500 bones. After 1500, the number of new taxa drops off, and will hypothetically level-out when it reaches the extent of taxonomic

[24] Grigson (1995) uses the "species richness" formula $d=S-1/\log_e N$ to describe the diversity of species in the animal bone assemblage from Grar. "Taxonomic richness" uses the same formula (described in Chapter 3, section 3.1.1.1).

diversity in the local environment[25].

The above analysis suggests that, up to a point, the taxonomic richness of the sample will increase as the sample size increases. After that point (in this case, above an assemblage size of 1000-1500 specimens), the species richness levels off. It is after that threshold where we can begin to consider other environmental and social factors that might come into play in the formation of the animal bone assemblage. Since the Afridar G assemblage indicates the highest species richness, we can assume that the threshold for the less diverse assemblages will occur at or before 1000-1500 specimens. Four of the seven assemblages in this study contain fewer than 1000 bones, and are therefore seen as less reliable samples than the larger assemblages. However, the 3 assemblages that comprise over 1000 bones represent each of the three sites—one from Shiqmim, one from Afridar (Area G), and one from the Halif Terrace (Late EB IB). These three assemblages, therefore, represent a spectrum of exploited species in each of the local environments. The implications of their taxonomic richness values will be discussed in the following chapter.

Caution must be taken when interpreting taxonomic richness values. As mentioned above, the taxonomic richness describes the diversity within the assemblage. This diversity reflects both environmental factors and human choices regarding animal exploitation. However, the extent to which it reflects one or the other is not easily determined. We can assume that two sites with diverse environments will have dissimilar taxonomic richness values. For example, Shiqmim and Afridar have very different environments, the former being arid and the latter wet. Not surprisingly, their taxonomic richness figures are very different, doubtless partially reflecting the disproportionate availability of species in these environments.

While the environmental influence behind the taxonomic richness differences is clear, the human choices that might affect or be affected by taxonomic richness are

[25] The spectrum of taxa in the local environment is seen here as the natural ceiling for taxonomic diversity in this assemblage. The picture could change dramatically, of course, given certain social or economic changes. For example, involvement in a long-distance trade network could diversify the faunal assemblage, adding taxa uncommon to this area.

not so easily understood. Given the more arid situation at Shiqmim, the inhabitants of the site likely undertook particular animal management strategies to cope with the marginal environment. These perhaps began as adaptations to their environment, and later developed into specialized strategies in a functioning system of production, regional exchange, and gift-giving.

During the Early Bronze IA we see a higher taxonomic richness at Afridar and the Halif Terrace. While it is not clear whether the Early Bronze IA inhabitants of these sites *intentionally* expanded their resource base as a risk reduction strategy, their movement into sites in areas of over 400 mm of rainfall allowed for a broadening of resources that would have promoted security during this time of potential instability at the end of the Chalcolithic.

A comparison of taxonomic richness can therefore indicate both environmental conditions and human actions, whether conscious choices or practical adaptations to the social and environmental situation. Further lines of evidence are required to substantiate the possible social implications indicated by site-to-site fluctuations in taxonomic richness. Caution is therefore taken in Chapter 6 when interpreting and discussing the results of taxonomic richness and how it relates to the other data.

5.1.1.2 Shiqmim

The animal bone assemblage from Shiqmim comprises 1558 identified specimens, representing 13 different taxa (Table 2)[26]. The domestic taxa at Shiqmim include sheep (*Ovis aries*), goat (*Capra hircus*), cattle (*Bos taurus*), dog (*Canis familiaris*), and horse (*Equus caballus*). Sheep, goat, cattle, and dog are among the most predominant from archaeological sites in this area since the advent of domestication. Horse is rare for the 4$^{th}$ millennium southern Levant. The few bones from Chalcolithic and Early bronze Age sites in the southern Levant (see section 3.1.1.2) have been said to be domestic, since wild horses are not known from this area in the Holocene (Grigson 1993). However, while the Chalcolithic horse bones might very well be the earliest horses known in the southern Levant, their domestic status is debatable. Recent studies suggests that the range of the wild horse extended much further than was previously thought (Levine 1999). The fact that the only Chalcolithic horse bones found in the southern Levant come from Grar and Shiqmim, two sites situated in the northern Negev, suggests that the open environment of the Negev might have harbored small populations of wild horses into Chalcolithic times.

The wild population represented at Shiqmim shows a predominance of taxa that prosper in arid conditions: gazelle (*Gazella* sp.), fox (*Vulpes* sp.), cat (*Felis* sp.), and hare (*Lepus* sp.). Gazelle bones from Shiqmim are not distinguished to species. While the smaller desert gazelle, *Gazella dorcas*, inhabits arid areas usually below the 100mm isohyet (Davis 1980b), the size of the gazelle bones from Shiqmim suggests that they are from the larger species *Gazella gazella*, the mountain gazelle. The Shiqmim assemblage includes one male gazelle horn core (Bone # Shiq93, 1109) with a wide groove on the frontal margin of the horn core and an elliptical cross-section, two distinguishing features of *Gazella gazella* (see section 3.1.1.2). The relatively small number of hunted taxa at Shiqmim implies that the inhabitants of the settlement did not regularly hunt wild animals. Alternatively, or perhaps additionally, wild animals were not abundant in the local environment.

#### 5.1.1.3 Afridar

The three areas of Afridar are considered together here. The assemblages from Areas E, F, and G together comprise 4107 identified specimens, representing 22 different taxa (Table 2). The seven domesticates that make up the majority of the Afridar assemblages are sheep (*Ovis aries*), goat (*Capra hircus*), cattle (*Bos taurus*), pig (*Sus scrofa*), dog (*Canis familiaris*), donkey (*Equus asinus*), and horse (*Equus caballus*). The presence of pig at Afridar indicates a wetter climate more appropriate

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[26] The relative proportions of taxa are omitted from Table 2 to place focus strictly on the presence or absence of various taxa.

for pig-keeping than that at Shiqmim. Areas E, F, and G of Afridar together provide specimens from 15 diverse wild taxa. Two male horn cores from Afridar Area G (AF 3283 and AF 1614) are identified as coming from *G. gazella* based on their elliptical cross-sections and frontal groove. Additionally, all of the measured gazelle bones from Afridar fall within ranges for *G. gazella* (compared with measurements given by Horwitz, Cope, and Tchernov (1990)). Bones from all three expected cervids are present: red deer (*Cervus elaphus*), fallow deer (*Dama mesopotamica*), and roe deer (*Capreolus capreolus*). Haretebeest (*Alcelaphus buselaphus*) bones are also present in the Afridar assemblage. Bird, fish, and tortoise are present, as expected in this wet, coastal environment. Crocodile (*Crocodilus niloticus*), while far from common, is not unexpected in this type of environment. Lion (*Panthera leo*) bones are extremely rare in archaeological assemblages from this period (their significance is discussed in Chapter 6).

Afridar is missing 2 taxa found at Shiqmim, hare and frog. As similar recovery procedures were used at Shiqmim and Afridar, the absence of hare and frog at Afridar might be due to poor preservation. A curiosity of the Afridar assemblage is the absence of both hippopotamus (*Hippopotamus amphibius*) and ostrich (*Struthio camelus*). Hippopotamus remains are found in one Chalcolithic site (Qatif Y) and several Early Bronze Age sites, all within the region of the coastal plain, and three of which are within close proximity to Afridar (Horwitz and Tchernov 1990, Fig. 4). The presence of crocodile (another Nilotic species) at Afridar would suggest that hippopotamus might also be found in the assemblage. Ostrich, whose remains are often noted in faunal assemblages by egg shell fragments, would find the sandy environment around Afridar a suitable habitat. While the absence of ostrich egg shell at Afridar might be a result of soil conditions or retrieval strategies, the bones of ostrich and hippopotamus would not be so easily overlooked. It therefore appears that these two taxa were either not available in the local environment or were not hunted for food. Perhaps they were only exploited for products that could be stolen (egg shells) or removed (tusks) outside the settlement and subsequently sent away from the settlement.

#### 5.1.1.4 The Halif Terrace

The three Early Bronze Age strata at the Halif Terrace produced a total of 1633 identified specimens, comprising 16 taxa (Table 2). The domestic assemblage comprises the same spectrum of taxa as was seen at Afridar. Sheep (*Ovis aries*), goat (*Capra hircus*), and cattle (*Bos taurus*) predominate in all three phases of the Early Bronze Age at the Halif Terrace. Pig (*Sus scrofa*) is also present, but in much smaller numbers than at Afridar. The location of the Halif Terrace in a slightly dryer environment than that of Afridar may have been one reason why humans chose not to exploit pigs to any significant extent at the Halif Terrace.

Bones of wild cattle (*Bos primigenius*) are present in all three phases at the Halif Terrace. Bones of wild pig are present in the last two phases. While bones of deer are absent from the Halif Terrace assemblage, those of hartebeest are present in all three phases. Remains of ostrich (*Struthio camelus*) are represented at the Halif Terrace in the form of an egg shell fragment.

### 5.1.2 Animal size

The average body size of animals in a herd can be associated with any number of factors, including diet, environment, health, and herd demographics. This study compares the average size of animals at each of the three sites to determine to what extent size is related to the local environment and to differential exploitation by humans[27]. The length and the breadth of bones depends on size and stature (a heavy animal will have broader, but not necessarily longer bones). The average body size of herds here will depend greatly on the sheep/goat ratio and the male/female ratio

[27] In the case of Afridar, I have limited this analysis to the data from Area G, by far the largest representative body of data for the site. A comparison of the Area E and F bones to Area G showed that Area G sufficiently represents the size of animals across the entire EB IA site. For the sake of simplification and clarity, Areas E and F are therefore omitted from this analysis.

within the herds. Measurements included here are predominantly breadths; however, some lengths (astragalus, calcaneus, phalanx 1 and 2) are also given. The results of this analysis can therefore be used to get a general impression of the body size of animals at these sites. However, they must be interpreted with caution, keeping these biasing factors in mind. The fact that the data from the Halif Terrace were collected by another zooarchaeologist hindered some inter-site comparisons of animal size. The measurements from the Halif Terrace focus on equid bones or unusual specimens of other taxa, but otherwise keep measurements on more common bones to a minimum. Measurements from the Halif Terrace were very helpful in assessing the nature of the equid population at the Halif Terrace. However, the small number of measurements on more common bones from the Halif Terrace limited an assessment of the general size of sheep/goat and cattle populations. A comparison of pig size from the Halif Terrace and Afridar could not be attempted at all due to the small number of pig bones and resulting dearth of measurements from the Halif Terrace.

5.1.2.1 Sheep and goat size

Comparisons of the size of sheep/goat from the three sites in this study are based on averaging one measurement per chosen element (described in section 3.1.2). The number of specimens useful for this particular assessment is much lower for Shiqmim (88) and the Halif Terrace (66) than for Afridar (274). This discrepancy has a number of explanations. The lower numbers at Shiqmim likely result from the paucity of fused bones in Shiqmim's assemblage. The lower numbers at the Halif Terrace reflect the methodology regarding measurements described above. The vast numbers of measurements from Afridar result in part to the large size of the assemblage from Area G. In spite of the discrepancies in the size of the data sets for this size analysis, there is a reasonably large data set from each site to attempt a comparison of the average size of animals.

Figure 2 shows the average measurements of selected sheep/goat (combined) elements from Shiqmim, Afridar, and the Halif Terrace. For the sake of clarity, ranges are omitted from Figure 2. However data for Figure 2, including all measurements, ranges, and averages, can be found in Tables 3a through 3c. The results indicate that the adult animals at Shiqmim were generally of smaller stature than those from Afridar, while those from the Halif Terrace are only slightly smaller than those from Afridar. It will be shown later that there is a significant difference in the ratio of sheep to goat in herds from Shiqmim, Afridar, and the Halif Terrace. Shiqmim has the lowest ratio, nearly 1:1. As goats are generally smaller than sheep, it is possible that the smaller stature of the sheep/goat population at Shiqmim is due to the higher number of goats in the herds than at the other two sites. To test whether these size differences can be attributed to differential herd composition, sheep and goat measurements for each applicable element (with ranges and averages) are plotted separately in Figure 2a. Data for this figure include all relevant bones that were confidently identified as those of sheep *or* goat (*not* to the more generalized category "sheep/goat"). These data are presented in Tables 3a through 3c, Sections II and III. While data from some elements are few (particularly for goat), and while there is a broad overlapping of ranges, Figure 2a indicates that for the majority of the selected elements those from sheep are on average larger than those from goat. More importantly, it shows that sheep from Shiqmim are, in nearly every case, smaller than sheep at Afridar and the Halif Terrace. This is more clearly demonstrated in Figure 2b, where average measurements from sheep elements at all three sites are plotted together. In every case but one (the Greatest Length of the calcaneus), the sheep from Shiqmim are smaller than those from the other two sites. While the body of data from goat measurements is too small from which to draw the same conclusion, the evidence from the sheep is sufficient to conclude that differences in the overall body size among sheep/goat populations at these sites are not reflecting herd composition. While herd composition must not be discounted, the observed size differences in this case seem more likely related to the local environment (where

Shiqmim is the driest of the three and therefore has more goats as well as smaller animals in general).

5.1.2.2 Cattle size

The size differences noted in sheep/goat bones which seem to reflect environmental location are substantiated by size differences in cattle, the other predominant species at the sites[28]. Tables 4a through 4c and Figure 3 show the relative sizes of cattle bones from the three sites. All measurements are given, and the same criteria used for sheep/goat were used for cattle. Figure 3 indicates variations in the size of cattle between the three sites. This size difference is similar to that noted in the average size of sheep/goat between the three sites (Figure 2). The data from sheep/goat and cattle suggest that size differences might be related to local environmental conditions, where the Mediterranean environment of Afridar would have provided more ample grazing for herds than that of either Shiqmim or the Halif Terrace[29]. Another possibility is that the smaller size of the cattle from Shiqmim represents a predominantly female herd for milking. Unfortunately, there are not enough diagnostic parts with which to determine a sex ratio among the cattle population.

The large size of the Afridar cattle raises the question of the potential presence of wild cattle, or aurochs (*Bos primigenius*). This analysis attributes only one cattle bone from Afridar, a calcaneus from Area G (AF 1702; Plate 1), to aurochs. The fusion line of the tuber is still visible, indicating a young individual, while the greatest length (163.7mm) is already within the low end of the range for wild cattle. This calcaneus is paralleled at Grar (Grigson 1995a), a site in the northern Negev, where a complete, recently fused calcaneus with a greatest length of 138.6mm has been tentatively identified as coming from *Bos primigenius*. When the cattle measurements from Afridar are compared with those taken on bones of an

[28] A size comparison between pig populations was not possible owing to the very small sample of pig bones from the Halif Terrace which provided very few useful measurements.

archaeological specimen of female aurochs from Denmark, the results indicate that four of the measurements on Afridar cattle bones fall into the lowest end of the range of the wild cow[30] (Figure 4 and Table 5). Three of these are metapodials (two distal, one proximal), and the fourth is the juvenile calcaneus mentioned above. The data thus indicate that the inhabitants of Afridar may have occasionally hunted aurochs. However, it is also possible that these measurements reflect animals of a heavier stature, which might point to the use of oxen at Afridar (discussed in section 5.3.2)

The cattle from the Halif Terrace, while larger than those from Shiqmim, are still slightly smaller than those from Afridar (Figure 3). The corpus of large bovid bones from the Halif Terrace for this study comprises 219 specimens. 14 were identified in laboratory analysis as coming from wild cattle, 20 are questionable wild cattle, and the remaining 185 are domestic cattle. Unfortunately, only six of the wild (and questionably wild) specimens provide the relevant measurements for a size comparison (see Table 6). When all the cattle bone measurements (from both wild and domestic cattle) are compared with the measurements taken on the Danish wild cow (Figure 5 And Table 6), four of the wild cattle specimens from the Halif Terrace are larger than those from the wild cow. While the sample size is small, the present data indicate that two thirds of the 34 bones identified as wild cattle actually fall well within the range for wild cattle. The remaining 12 may be small wild individuals or large specimens of domestic cattle.

While the results regarding both the environmental situation and differences in human use of cattle are intriguing, the overall problem of small sample size for cattle at all three sites indicates that these results must be interpreted with caution.

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[29] However, further analysis *within* populations might reveal information about size in relation to herd composition.

[30] The use of a female *Bos primigenius* is useful because it allows for comparison against the lower end of the range for wild cattle. However, as Grigson (1986:Fig.2) illustrates, dimensions from certain female wild cattle specimens also fall below the measurements from the standard female Danish specimen. We must therefore consider that some of the cattle measurements from Afridar and the Halif Terrace that fall at or above -0.08 might also come from wild cattle.

### 5.1.3 Skeletal disorders pertaining to pasturage

Skeletal disorders occur on animal bones and teeth in the same way they occur among human populations, as a result of injury, infection, and disease. This section describes the skeletal disorders on bones and teeth of animals from Shiqmim, Afridar, and the Halif Terrace that provide insight into the environmental constraints within which the animals lived. As many skeletal disorders result from human exploitation of animals, a discussion of chronic conditions and pathologies continues in greater detail in section 5.3.2.3 in a discussion of the use of cattle for labor.

Evidence of skeletal disorders was noted on a very small number of bones from all three sites (Tables 7 through 9). At Shiqmim, 2% of the total sheep/goat assemblage 1% of the cattle assemblage show signs of chronic conditions. At Afridar and the Halif Terrace, 1% of the entire sheep/goat and cattle assemblage has visible signs of tooth and bone disorders. For all three sites under study, the majority of sheep/goat disorders occur on teeth. The most predominant problems among teeth are swollen root tips and dental calculus, usually occurring among older individuals (generally, over 3-4 years old, or Payne's (1973) wear stage F) (Plate 2). Swollen roots can result from chronic low-grade infection (Baker and Brothwell 1980:151), perhaps from many years of bacterial infections from grazing in unfavorable pasturage low in nutrients. In her study of the 1982-83 excavations at Shiqmim, Grigson also noted swollen root tips among the sheep/goat teeth, a condition she attributes to periodontal infection which "may indicated the over-use of infected pasture or overcrowded conditions, or both" (Grigson 1987:225). A calculus (tartar) build-up is also noted on a number of sheep/goat teeth, reflected in a gold metallic luster observed on the buccal and/or lingual sides of the teeth. Tartar build-up reflects the health and functioning of the teeth (Baker and Brothwell 1980:151), and may also be another indication of poor grazing conditions (overcrowded or lacking in nutrients). The majority of the cases of calculus and swollen roots at all three sites occur on the teeth of adults, suggesting that their occurrence is not only common and rather innocuous, but also a gradual development. The higher occurrence of calculus and swollen root tips among the Shiqmim sheep/goat compared to the other sites may be related to grazing in the northern Negev environment which could have involved the intake of sand, a potential irritant and cause of infection. It might also indicate that the sheep/goat at the other two sites were better controlled and cared for. In her study of Late Neolithic Tell Sabi Abyad, Cavallo (1997:65) sees oral pathologies as related to environment and pasture. She notes a decrease in oral pathologies from the Pre-Halaf to the Early Halaf. She suggests this decrease might be attributed to better care and control of sheep/goat in the later period (a period that also might be characterized by environmental degradation). The fact that no cattle teeth from Shiqmim show signs of calculus or swollen roots suggests that either cattle do not as frequently develop these types of conditions or that the Shiqmim cattle were fed or treated differently than the sheep/goat.

The second most predominant area of pathological occurrence among sheep/goat is the feet (Tables 7 through 9), where exostosis occurs on a total of 8 first and second phalanges from all three sites. Exostosis on foot bones can reflect injuries/infections from treading on rocks or thorns (Bökönyi 1977:38). Infections of the foot can also occur in overcrowded pasture high in bacteria. The hoof area of the foot is an easy target area for the invasion of bacteria, often resulting in low-grade infections that cause swelling and eventual deformation of the bone. The occurrence of foot pathologies is higher at Shiqmim than at Afridar and the Halif Terrace. Foot pathologies constitute about 25% of sheep/goat skeletal disorders at Shiqmim, but only 10% or less at Afridar and the Halif Terrace. This might indicate crowded or more frequent penning of the animals at Shiqmim. It also might reflect a more strenuous habitat, the sheep/goat from Shiqmim having to graze over a wider and less nutritious area than those from Afridar or the Halif Terrace, a theory that fits with the higher occurrence of swollen roots and dental calculus. While the majority of affected foot bones consists of phalanges, some metapodials show signs of pitting or additional bone growth. One goat metatarsal from Shiqmim (see Table 7) is identified as coming from a female goat, possibly indicating pathology due to calcium drain and bone thinning associated with intensive milking.

Among cattle, 13 of 14 cattle bones with pathologies from all three sites are foot bones (Tables 7 through 9). Shiqmim has only two pathological cattle bones, one of which is a classic example of strain from draught (this bone, a metapodial with grooves on the distal articular surface, is discussed in detail in section 5.3.2.3). The other is a thoracic vertebra with exostosis on the tuber of the spine. Since these and the entire corpus of pathological cattle bones might be attributed to the use of cattle for labor, an entire section is dedicated to their discussion (section 5.3.2.3). The one observation that can be made about cattle pathologies in this section is that the same types of pathologies thought to reflect poor pasture among sheep/goat are not observed on cattle bones and teeth. This probably reflects the different feeding behaviors of the two species, and to the fact that there are far fewer cattle than sheep/goat bones at all three sites. These issues will be discussed further in Chapter 6.

### 5.2 Primary products

Having determined areas where biases in the assemblages might occur due to local environmental conditions, we can now move on to the evidence in the zooarchaeological assemblages that pertain to human activities. Primary use of animals (specifically for meat) at Shiqmim, Afridar, and the Halif Terrace is assessed here using four lines of evidence: bone fragmentation, butchery patterns, the relative percentage of taxa at each site, and kill-off patterns. The extent of primary products usage can then be contrasted with the use of particular taxa for secondary products (addressed in section 5.3).

### 5.2.1 Relative percentages of taxa

Table 10 shows the relative percentages of taxa at Chalcolithic and Early Bronze Age sites in the southern Levant. The taxa present and their relative percentages seem to generally reflect the location of the site from which the bones were retrieved. For example, settlements such as Arad, Bir es-Safadi, and Abu Matar, located in southern arid zones, have more sheep/goat, fewer cattle, and no pigs (Ducos 1968; Hanbury-Tenison 1986; Lernau 1978). The relative percentages of taxa from Shiqmim, Afridar, and the Halif Terrace fit into this general picture across the sample of southern Levantine sites. However, finer differences are apparent upon intra-assemblage analysis.

Tables 11 through 13 detail the relative frequencies of taxa at Shiqmim, Afridar, and the Halif Terrace. Sheep/goat and cattle predominate in the assemblages from all three sites. The presence of sheep/goat is highest at Shiqmim, the most arid of the three sites. Sheep/goat numbers are lowest at Afridar (30% of the assemblage), affected by the high numbers of pig and equid bones in the assemblage. In area G the proportion of sheep/goat jumps to 56.8% of the assemblage, while equids drop to just under 2%. At the Halif Terrace, sheep/goat numbers increase over time, at the expense of all other taxa but cattle. Cattle numbers range from between 10% to 30% of the assemblages. They are highest in all areas of Afridar, as are proportions of pig bones. Cattle are most frequently represented at Afridar Area F (29% of the assemblage), the area also comprising the highest proportion of equid remains (15.8%). These temporal and location-specific fluctuations in the proportions of taxa indicate changing husbandry practices over time and in different environmental and social situations. Chapter 6 elaborates upon the significance of these differences in the overall picture of husbandry practices in the Chalcolithic - Early Bronze IB.

Equid bones are found at all three sites, but only at Afridar and the Halif Terrace in significant proportions. At Afridar, equid bone remains make up 20.9% and 14.9% of Areas E and F, respectively. These surprisingly high proportions of equid bones contrast with Area G of the same site, which has less than 2% equid remains. Equid remains are present in all phases of the Early Bronze I at the Halif Terrace (Table 13). Interestingly, their numbers decline over time, from 13.2% in the EB IA to 8.4% in the early EB IB, and finally to 6.1% in the late EB IB. This diachronic decline (a drop of over half the represented assemblage) indicates a marked transition from the earliest phase to the latest phase of the Early Bronze I. The high numbers of equids at Afridar indicate some kind of frequent exploitation, a factor which must have had a tremendous effect on the social and economic situation of the people, as will be discussed later.

While the frequencies of sheep/goat, cattle, and equid fluctuate from area to area at Afridar, pig numbers remain surprisingly stable, the largest variation being from 15.4% to 15.8% (Table 12). The number of pig bones in the assemblage from the Halif Terrace is much smaller; however, relative percentages indicate that there is a slight decline in the presence of pigs over time, from 2.8% in the EB IA to 1% in the EB IB. Scholars debate the presence or absence of pigs in faunal assemblages from the Near East, which might result from environmental conditions, political structure, or dietary taboos, to name a few (Grigson 1995b; Hesse 1990; Zeder 1996). Chapter 6 discusses the pig data from the present study in light of various theories regarding the presence of pig in Near Eastern assemblages.

### 5.2.2 Food preparation

#### 5.2.2.1 Fragmentation

The degree of bone fragmentation can indicate how intensively people used a carcass. The bones of meat-providers are often subjected to a higher degree of fragmentation than those of equids and dogs, animals with predominantly non-food purposes. An example from Afridar G (Figure 7) shows that the bones of sheep/goat and pigs are more highly fragmented than those of equids and dogs. The cattle at Afridar fall somewhere in the middle, suggesting that they had a divided purpose, and were perhaps not as regularly eaten as sheep/goat and pigs. However, the bones of cattle are generally more robust than those of sheep/goat and therefore subject to a lesser degree of fragmentation. When an animal carcass is processed for meat and other primary products, activities such as dismembering, butchery, and crushing for marrow extraction, cause the bones to become fragmented. Cooking activities such as boiling and roasting make the bones weak and more easily friable. Butchery and cooking debris is then discarded, where it is exposed to the elements, to trampling and gnawing by scavengers. In contrast, the carcasses of non-food animals are more likely to be buried or discarded away from the site and thus outside the excavated area. To facilitate comparison between all three sites, Figure 8 shows the number of complete bones compared with the total number of bones for the predominant taxa at each site. Sheep/goat, pig, and cattle have a very low percentage of complete bones. This is expected, since these animals were probably the main meat sources. Dog and equid show a much more frequent occurrence of complete bones, having not been subjected to the same types of butchery and processing as the bones of the food animals.

5.2.2.2 Butchery

Butchery encompasses human activities involved in the preparation of the animal carcass for consumption. Aspects of butchery such as cut marks and the selection and disposal of parts can provide information about specialization, social status, and ethnicity (Crabtree 1990). In this analysis skinning (removal of hides), de-fleshing (removal of meat and sinews), dismembering (separation of limbs), and meal preparation (chopping, boiling, etc.) make up the discussion of butchery at each site. Direct comparisons of cut mark frequency and location on an inter-site level is only possible for Shiqmim and Afridar. At Shiqmim and Afridar, the type of cut and its exact location was noted, as well as the type of shaft fracture. At the Halif Terrace, shaft splitting is the more common type of butchery mark recorded. Because of these two different methods of noting cut marks, inter-site analysis focuses more on location rather than type. A description of methods used to identify cut marks and the significance of cut marks can be found in section 3.2.4.2.

Tables 15 through 20 list the frequency and location of cut marks for the predominant taxa at Shiqmim, Afridar, and the Halif Terrace. For sheep/goat (Table 15), cut marks indicate that disarticulation would have occurred as follows: the horn cores were removed at the base, the head was severed from the body somewhere along the atlas-axis area, the upper limbs were separated at the distal and proximal articulation areas (indicated by the high numbers of cuts on articular ends rather than shafts[31]), and the lower limbs were cut off at the carpals/tarsals or proximal metapodials (see Illustration 4). A high occurrence of cut marks on the proximal metapodials and tarsal bones indicates that butchers normally removed all bones distal to the tarsal/carpal areas as a whole. Evidence that the butchers often discarded these lower limb bones as a whole (without any further processing, such as boiling) is found in the high occurrence of articulated bones distal to the tarsals/carpals[32]. To illustrate this point, Tables 21 through 25 list all the elements found in articulation in excavation. The majority of articulating bones are from the lower limbs and feet, that is, tarsals/carpals, metapodials, and phalanges.

Most of the cut marks on cattle bones from the three sites occur on tarsals, in particular the astragalus, and on the shaft of the radius (Table 16). While there are too few data to determine any specific butchery practices, cut marks and articulations (Table 22) indicate that the extremities in cattle were similarly discarded as those of sheep/goat.

Three of the six cut marks on pig bones are from the pelvic area (Table 19). The ball and socket joint of the femoral caput-acetabulum articulation is one of the tightest joints in the mammalian skeleton. Furthermore, in carnivores and pigs the acetabulum is tighter joint than in ungulates. This probably explains the higher frequency of cut marks on this particular area of the pig. Other than cuts on the

[31] The paucity of cut marks on shafts might simply be due to the fact that articular ends are more readily distinguished than shaft fragments, giving the impression that more ends are cut.
[32] Evidence indicates that people sometimes had other uses for these non-meat-bearing parts of the carcass. Metapodials provide long, straight, sturdy shafts for tool-making. Indeed, the tool kit from Shiqmim includes bone awls and a copper awl mounted in a handle made from a sheep/goat metapodial (Grigson 1987::Fig. 15.18:1).

pelvis, pig bones show very few signs of butchery. Of the 644 pig bones from Afridar, less than one percent have cut marks. The paucity of cut marks on pig bones might be due to the predominance of juveniles in the pig population. Unfused epiphyses do not preserve as well and are not as easily identified as fully fused bones. Additionally, unfused bones may disarticulate more easily, lowering the potential for cut marks. Not only are unfused epiphyses less well preserved in the archaeological record, but their unfused state might have also facilitated disarticulation.

Cut marks are present on very few equid bones from the three sites under consideration (Table 17). One of the two equid bones from Shiqmim, a radius (Bone # SHIQ 1632), has possible cut marks on the distal articular end. The deposition of this radius in a stratum I deposit and the color of the bone, which was different than the other archaeological bones, raises the question as to whether this bone might be intrusive. No weight will thus be placed on the significance of cut marks on this particular bone. Cut marks are present on three of the equid bones from Afridar, a proximal metacarpal, a distal metatarsal, and a proximal femur. Seven cut marks on equid bones from all three phases at the Halif Terrace include proximal and distal ends of the radius, proximal and distal ends of the metapodia, a distal femur, and a second phalanx. Cut marks on bones of the feet such as the metapodia might result from skinning.

### 5.2.3 Kill-off patterns

#### 5.2.3.1 Sheep/goat mortality

Mandibular tooth eruption and wear data from Shiqmim show a high kill-off of animals up to two years of age. Over two thirds of the 52 mandibular teeth and tooth rows with determined wear patterns were from animals killed at two years or younger. This is evidenced graphically in a dramatic drop in numbers from 0-1 year and from 1-2 years (Figure 10). Epiphyseal fusion of sheep/goat bones from Shiqmim show a strikingly similar kill-off pattern, with over 70% of the animals not surviving past about two years of age (Figure 11; Table 26). This kill-off of a majority of young sheep/goat at Shiqmim corresponds with the pattern for a strategy optimizing for milk (see Figure 9).

The largest data set, that from Area G, is used to determine kill-off patterns on the whole at Afridar. Afridar G provides 156 applicable mandibles and mandibular teeth. The pattern indicated by these teeth suggests kill-off at a somewhat older age than at Shiqmim. Less than half of the individuals were killed before 2 years of age (Figure 12). The most significant jump in kill-off at Afridar is between 1 and 2 years of age, but generally the annual decline is steady. While bone fusion data from Shiqmim indicate a dramatic kill-off in the first two years, bone fusion data for sheep/goat at Afridar show a maintenance of about 80% of the herd to over 2 years of age (Figure 13; Table 27)[33]. A drop-off to 30% survival occurs only after three years of age. Overall, the bone fusion at Afridar shows the most significant kill-off occurring about one year later than at Shiqmim[34]. The present data indicate that some young animals at Afridar were eaten, but the majority of the animals were maintained about a year longer than those at Shiqmim, or to 2-3 years, the prime age for meat kill-off.

Mandibular data from the Halif Terrace indicate that the greatest kill-off falls at 3-4 years (Figure 18)[35]. While both Shiqmim and Afridar have only about 15% of the individuals surviving past 4.5 years (slightly higher at Afridar), over 30% of the sample from the late EB IB Halif Terrace survive past 4.5 years. Epiphyseal fusion data substantiate these findings (Figures 15, 17, and 19; Table 28). Only about 30% of the individuals at Shiqmim and Afridar survived beyond 2.5-3 years, while up to 60% of the individuals at the Halif Terrace are over 2.5-3 years, and 40% survive

[33] In light of taphonomic factors that might reflect a disproportionately low number of juvenile pig bones at Afridar (discussed in section 5.2.3.3), the number of sheep/goat surviving beyond two years of age might be lower than the data indicate.
[34] The most significant kill-off occurs in the third age category (ca. 2.5 years) at Afridar and in the second age category (ca. 1.5 years) at Shiqmim (see Figures 11 and 13).
[35] The late EB IB, with the largest sample of mandibular data, is used to determine the general picture of kill-off of sheep/goat at the Halif Terrace.

beyond 3-3.5 years (the oldest category for bone fusion) (Figure 19)[36]. It thus appears the sheep/goat population at the Halif Terrace, particularly in the late EB IB (and perhaps in earlier periods), comprised a much higher proportion of older individuals than at Shiqmim or Afridar. These data suggest that the inhabitants of the Halif Terrace maintained sheep/goat for more intensive secondary products exploitation, perhaps for wool, than at the other two sites.

Perhaps the most outstanding feature of the Halif Terrace mandibular data is a total absence of specimens from Payne's (1973) category "D", representing 1-2 year olds. While the sample sizes from the EB IA and early EB IB are rather small, with 16 and 7 specimens, respectively, the sample from the late EB IB comprises a more reliable sample of 43 specimens. Stage "D" is frequently the most abundant stage because it is a prime kill-off age, as can be seen at Shiqmim (Figure 10), Afridar (Figure 12), and in Payne's hypothetical kill-off patterns (Figure 9). The complete absence of stage D mandibles and teeth at the Halif Terrace is highly significant and may indicate a specialized husbandry strategy involving selective maintenance of animals of particular ages. The significance of this absence to the greater picture of EB I husbandry practices is discussed in Chapter 6.

5.2.3.2 Cattle mortality

Cattle mortality estimates are based on bone fusion stages taken from Silver (1969). At Afridar, almost 70% of the bones for which fusion data could be noted come from animals surviving beyond the age of two and a half years. Additionally, nearly 50% of the bones in the latest-fusing category (3.5-4 years) are fused (Figure 21; Table 27). These data suggest that the majority of the cattle were maintained to adulthood, perhaps for their exploitation as labor animals.

The picture is slightly different at Shiqmim, where there is a higher percentage of unfused bones in each of the three fusion categories than at Afridar (Figure 20;

[36] In this case, as in the case of mandibular data, the interpretation of mortality patterns at the Halif Terrace is based on data from the late EB IB, the period with the largest sample of applicable bones.

Table 26). In fact, over 80% of the bones from the 3.5-4 year category are unfused, indicating that cattle at Shiqmim were normally killed before reaching maturity, the point at which the cost of their maintenance exceeds their production in meat yield. Further evidence that cattle might have been used for meat at Shiqmim is found in cut marks on an articulating group of limb bones (calcaneus, astragalus, centroquartal and metatarsal) from a young individual. The calcaneus and astragalus have heavy cut marks on the lateral side, indicating an attempt to sever the extremity from the meat-bearing upper limb. The unfused calcaneus reveals that the animal was less than three years old when it died, suggesting that it was butchered at a young age. While the fact that these bones were found in articulation is evidence that they were discarded and *not* eaten, the butchery of a young animal suggests that it was killed for its meat.

Cattle mortality at the Halif Terrace could only be assessed for the Late EB IB due to the small number of cattle bones from the site (Figure 22; Table 28). The sample of 38 bones represents an assemblage comprising predominantly young animals. In fact, the Halif Terrace reflects a more extreme decline from the first to the second age categories than either Shiqmim or Afridar. Only about 15% of the individuals in the sample survived beyond 3.5-4 years, not yet the point of maximum growth. These data indicate that the inhabitants of the Halif Terrace used cattle predominantly for meat.

### 5.2.3.3 Pig mortality

In spite of the high caloric and fat content of primary pig products, pig remains from sites in the southern Levant often comprise a small portion of faunal assemblages (often less than 10%) (Zeder 1996). This seeming under-exploitation is likely due to a combination of pig management requirements and local environmental conditions (discussed in Chapter 2 and Chapter 6) (Zeder 1991:30-31). Where they are present, however, pig remains are comprised predominantly of juvenile bones, indicating their use primarily, if not exclusively, for meat. It is not surprising, then, that over 75% of the bones and teeth in the Afridar assemblage are from animals that died before two years of age (Table 27) indicating that pigs were produced solely for their primary products. The absence of unfused pig bones under one year at Afridar Areas E and F might be accounted for by the small sample size (24 and 11, respectively). The salty soil and the fact that many bones from Afridar also showed signs of dog gnawing are taphonomic factors that might also account for the low representation of unfused bones where we expect to see more. Unfused, fatty pig bones are prime candidates for carnivore consumption, and are weak and friable in wet, salty soil conditions. We must consider the possibility that the same taphonomic factors apply to the juvenile bones of other taxa as well. While carnivore gnawing is indicated on a few bones from all three sites, it is most predominant at Afridar.

The paucity of pig bones at the Halif Terrace prohibits a comparison of mortality patterns. However, as pigs provide little in the way of secondary products, it is likely that the domestic pigs from the Halif Terrace were killed at a young age for food. No pig bones were recovered from the excavated area at Shiqmim.

#### 5.2.3.4 Equid mortality

While equids are best known for their secondary products, carrying or pulling loads, their large size would, in theory, make them a convenient meat source, much like cattle. The three equid bones at Shiqmim, a proximal humerus, a proximal radius, and a distal radius are all fused, indicating a maximum of three animals over the age of 3.5 years, 18 months, and 3.5 years, respectively (fusion stages from Silver (1969)). A taxon represented by large numbers of bones indicates some frequent or large-scale use, suggesting food production or intensive exploitation for some other product. The large numbers of equid bones at Afridar Areas E and F lead us to consider that the equids were eaten. Like most Chalcolithic and Early Bronze Age sites in the southern Levant, Afridar's assemblage has very few wild animal bones (8% overall).

If the equids were wild, their presence would indicate a hunting strategy at Afridar focused strictly on equids. This possibility is highly unlikely, given the overall predominance of domestic animals at the site, the relative lack of butchery, and the differential disposal of equid bones. The Afridar assemblage comprises only 5 unfused bones, of a total of 27 equid bones for which fusion information could be noted. The equid assemblage from the Halif Terrace comprises similar proportions of fused and unfused bones: in the EB IA, 18 are fused and 3 unfused; in the Early EB IB, 7 are fused and 1 is unfused; in the Late EB IB, 17 are fused and 2 are unfused. This indicates that the majority of the equids at Afridar and the Halif Terrace survived to adulthood, normally beyond 3.5 years. They were thus likely not an important part of the diet. Other evidence for equids not being a common food item has already been mentioned— the equid remains are not as highly fragmented as are the bones of food animals (Figure 8). Additionally, equid bones are often found articulating (Table 29; Plate 5), indicating minimal post-mortem disturbance. This type of preservation attests to a differential treatment and disposal of equid remains, as opposed to common food animals.

5.2.3.5 Dog mortality

Dog bones are found in small numbers at Shiqmim, Afridar, and the Halif Terrace. As dogs are frequently pets or herders, their bones are more likely to be found articulating and with little breakage, suggesting that they were not processed in the same way as the common food animals. Indeed, dog bones are the most frequently articulating of all the major domesticates at all three sites (Table 29). Additionally, complete or nearly complete dog skeletons were excavated at Afridar Area E and at the Halif Terrace in the EB IA (Table 25). At Afridar and Shiqmim, all the dog bones for which age could be determined are from adult animals. At the Halif Terrace, 20 dog elements are fused, two are unfused, and five come from a fetal or newborn puppy. Bones from puppies are absent from both the Afridar and the Shiqmim assemblages.

## 5.3 Secondary products

Section 5.2 presented analyses pertaining to the use of primary products of animals, specifically meat. The data indicate that animals at the three sites did not serve a singular purpose as meat providers. Kill-off patterns, butchery marks (or the absence of butchery marks), the presence and absence of certain taxa, and fluctuating numbers of species all point to varied and changing uses of animals. This section, therefore, explores the potential of the various taxa represented in each assemblage for exploitation *beyond* primary products. As results from the previous section indicate that pigs were strictly meat providers, they are omitted from this discussion of secondary products. Results in this section focus on the evidence for milk production among sheep/goat, labor among cattle and equids, and pet-keeping among dogs.

### 5.3.1 Sheep/goat milking

Mortality patterns discussed in the previous section suggest that, while many sheep/goat were killed for meat, a portion of the herds was maintained to older ages. Milk as a secondary product was likely exploited long before the Chalcolithic-Early Bronze I. However, this is the first period that proposes an *intensification* of sheep/goat milking. Sheep/goat kill-off patterns, herd composition, and bone thickness are assessed here to provide results for the support or rejection of this proposition.

#### 5.3.1.1 Sheep/goat mortality: Indications for milking

Analysis of the data regarding sheep/goat kill-off patterns discussed above (section 5.2.3.1) reveals specific survivorship curves at each of the three sites under study. Comparing each of the survivorship curves with those hypothesized by Payne (Figure 9), results indicate the following: Shiqmim's survivorship curve

(Figure 10), with the majority of animals killed under one year, most closely resembles Payne's strategy for milk production and breed selection (Figure 9b). The kill-off at Afridar G (Figure 12) falls somewhere between meat (Figure 9a) and wool/breeding selection (Figure 9c), with more emphasis on meat optimization. Finally, the kill-off from the largest of the Halif Terrace assemblages, that from the late EB IB (Figure 18), indicates a strategy with the same decline as Afridar, with one important difference. At the Halif Terrace, samples representing category "D", the 1-2 year age category, are entirely absent (Figure 18). In the absence of kill-off in category "D", the survivorship curve from the Halif Terrace falls one year higher than that from Afridar. While the curves from the two sites are the same shape, the Halif Terrace curve runs parallel but older than the Afridar curve. This emphasis on older individuals suggests that the inhabitants of the Halif Terrace, like those of Afridar, kept sheep/goat for wool and meat. However, the inhabitants of the Halif Terrace kept animals into older ages, perhaps placing greater emphasis on wool exploitation.

5.3.1.2 Sheep/goat herd composition

Herd composition is used here to describe the ratio of sheep to goat in herds from Shiqmim, Afridar, and the Halif Terrace. The proportion of sheep to goat in herds reveals information both about the ability of the environment to sustain sheep and goat, and about the motivations of the herder. Results of these analyses are given in Table 30.

The 1993 faunal assemblage from Shiqmim included a total of 118 bones identified as sheep and 99 as goat, suggesting that, based on the 1993 sample, the average ratio of sheep to goat at Shiqmim was 1.2:1. Given the small sample size and the statistically insignificant predominance of sheep[37], we can presume that this ratio reflects a more or less equal number of sheep and goat at the site. This indicates that

[37] A chi-squared test performed on the data, with an expected sheep to goat ratio of 1:1, showed the 0.2 difference to be statistically insignificant.

the goal of herding at Shiqmim was herd security, fitting with Redding's suggestion that sheep/goat herding in the Middle East is focused on herd security.

The average ratio of sheep to goat in all areas of Afridar averages 3.5:1. Due to encrustation and to the friable condition of the bones from Area F, the distinction between sheep and goat was impossible to make in all cases save 9 bones identified as sheep and 6 as goat, resulting in a ratio of 1.5:1. In Area E, a slightly larger sample of 18 sheep and 7 goat bones, the ratio is 2.6:1. The largest area, Area G, provided a much higher sheep/goat ratio of 4:1, of a total of 130 sheep and 32 goat bones. Taking the largest sample, that from Area G, as the most reliable, it appears that the sheep/goat ratio at the coastal site of Afridar was about 4:1. A herd composition comprising 75% sheep is said by Redding to reflect either a herding strategy optimizing for energy/protein, or a situation where the environment was sufficiently temperate and wet to provide a more suitable habitat for sheep rather than goat. The emphasis on sheep might also reflect a herd security strategy aimed at assuring a source of wool.

Sheep/goat ratios from the 1994/95 assemblages from the Halif Terrace are as follows: EB IA: 1.8:1, based on 24 sheep and 14 goats; Early EB IB: 1.7:1, based on 15 sheep and 9 goats; Late EB IB: 2.3:1, based on 104 sheep and 45 goats. While the sheep/goat ratio at the Halif Terrace remains basically the same in the EB IA and the early EB IB, there is a slight shift to more sheep in the late EB IB. The overall ratio indicates that herd security was the goal at the Halif Terrace, with slightly more emphasis on sheep in the EB IB, perhaps with increasing wool exploitation.

#### 5.3.1.3 Radiographic analysis

Radiographic analysis of sheep/goat metapodia has been shown to reveal a reduction in cortical bone mass thought to be related to calcium drain from intensive milking (Smith and Horwitz 1984). Especially relevant to the present study are Smith and Horwitz's results in which they noted a reduction in bone mass between the Chalcolithic and the Early Bronze Age at sites in Israel and the West Bank (Smith and Horwitz 1984). This reduction they suggest may indicate changing herding strategies, and the intensification of milking of sheep and goats in the Early Bronze Age (Smith and Horwitz 1984). The preponderance of juvenile sheep/goat bones in Chalcolithic sites is replaced in the Early Bronze Age by a majority of adult bones, indicating secondary products exploitation (Horwitz and Smith 1991). This, together with the reduction in cortical bone mass, indicates that milk was the secondary product responsible for these changes.

To test these conclusions, 26 metapodia from Early Bronze IA Afridar were radiographed for cortical thickness measurements[38]. It was hoped that the Early Bronze I metapodia from Afridar would be comparable with the metapodia used in Smith and Horwitz's study to see if intensive milking could be detected in the EB I. The results of this study are presented in Tables 31a-31b.

Results from Afridar indicate that metatarsals show a higher average cortical thickness than metacarpals, regardless of sex. This difference is physiological, the metatarsal being longer and thinner than the metacarpal and thus having denser cortical bone than the metacarpal[39] (Smith and Horwitz 1984). The cortical thickness values for the metapodia of sheep are, on average, higher than those of goats (Table 31b). This might also be explained physiologically, for the metapodia of sheep are longer than those of goats, and thus have thicker cortical walls. Finally, there is a difference in the cortical thickness of males and females, that of females being lower than males (Table 31a). The lower bone mass among females results from the stress of gestation and calcium drain from lactation. We are interested in determining the *intensification* of lactation, so these differences between males and females are integral to this study. As Afridar spans one continuous EB IA phase, the results need to be compared against those from Smith and Horwitz (1984) to see

[38] The metapodials from Afridar were radiographed using the facilities at the Royal Infirmary of Edinburgh. To increase the sample size, the metacarpals and metatarsals chosen for the study were all those over 50% complete that could be confidently distinguished as sheep or goat, and male or female. Radiographing procedures followed specifications laid out in Horwitz and Smith (1991). Each of the radiographed bones was subsequently measured three times with Vernier calipers, the resulting cortical thickness being the average of the three measurements.

[39] This difference is upheld in three of the five cases in Horwitz and Smith's (1991) results.

where they fall in the proposed shift to intensive milking in the Early Bronze Age. Unfortunately, the cortical thickness for all radiographed metapodia from Afridar are, on average, about one millimeter larger than the results obtained by Horwitz and Smith (Table 31b), resembling more closely Horwitz and Smith's data from the Neolithic (Horwitz and Smith 1991:37, Table 3).

Approaching the data from a different angle, looking not at average cortical thicknesses, but at the *difference* between the average cortical thickness between males and females, the Afridar results become more informative. The cortical thickness among male sheep/goat is, on average, 11% higher than the cortical thickness of females at Afridar. Unfortunately, this cannot be compared with the results from Horwitz and Smith because they did not separate males and females. This incongruity in the results prevents the placement of Afridar in their model, thus preventing any conclusions regarding the magnitude of milking at Afridar.

Explanations for these differences are numerous[40]. Differences in the body size of individuals comprising a population might explain the larger cortical thickness derived from the Afridar sheep/goat metapodia. Indeed, we have already observed the much greater size of the Afridar sheep/goat when compared with Shiqmim. Although all fused bones were used here, variations in age might skew the results. Perhaps the most important factor contributing to potential misinterpretations of the data involves Early Bronze Age chronology. The Early Bronze Age is a highly diverse period, changing from small-scale, decentralized societies in the EB IA, to more sedentary, denser populations and larger settlements in the EB IB, to the first walled settlements in the EB II and III, and again to a period of ruralization in the EB IV/MB I. Smith and Horwitz's study does not distinguish between different phases of the Early Bronze Age. While they observe a decrease in cortical thickness from the Early Bronze Age to the Middle Bronze Age, more specific chronological distinctions are not made. While intra-population analysis of cortical thickness in

[40] Technical limitations of this method include difficulties encountered in replicating the exact radiographing conditions (such as the exposure time), and precise measurement of the smallest breadth of the shaft, especially in the case of the long, straight shafts of sheep metapodia.

sheep/goat metapodia from Afridar provides information about the Afridar sheep/goat population, the results are incompatible with those obtained by Horwitz and Smith from other sites in Israel and the West Bank, thus preventing a determination of the magnitude of milking in the Early Bronze IA at Afridar when compared with earlier and later periods[41].

### 5.3.2 Cattle as beasts of burden

#### 5.3.2.1 Cattle mortality: Indications for draught

The proportion of cattle in the faunal assemblages from Shiqmim, Afridar and the Halif Terrace is generally less than 20%. While the proportion of sheep/goat is much higher, in meat-yield terms cattle exploited for beef would make the most substantial contribution to the diet (up to ten times more meat than sheep/goat and five times more than pig) (Clark and Yi 1983; Grigson 1995b:260, Table 1). Fusion data for cattle at all three sites (discussed in section 5.2.3.2) show a significant kill-off of individuals before maturity, and usually beginning around 2 years (Figures 20-22). However, the population at Afridar show a tendency towards maintenance of cattle into older ages than the other two sites: at Afridar G, about 35% of the individuals in the final age category are fused (while only 20% are fused in the same category for Shiqmim, and only 15% at the Halif Terrace Late EB IB). This might indicate that, while cattle were used primarily for meat, a few were maintained to older ages, perhaps for traction. The picture at Afridar suggests a slightly more intensified use of cattle for some secondary products that allowed for over 35% of the population to survive beyond maturity. These indications of secondary products usage necessitate an exploration of other lines for cattle exploitation, namely, size differences within and between populations, and the location and nature of pathologies on cattle bones.

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[41] A comparison of the Afridar data with metapodia from Shiqmim would have been ideal. Unfortunately, sheep/goat metapodia from Shiqmim were not available for this study. They have been set aside for analysis by Liora Horwitz. We hope future results will be comparable with those presented in this study.

5.3.2.2 Size

Of the corpus of cattle bones from all three sites, a small number were identified in the laboratory as coming from wild cattle. Comparison with the measurements from a common wild standard, a female *Bos primigenius* skeleton from the early Boreal in Denmark[42] (Figure 4 and 5), confirms that a few of the cattle bones do, indeed, fall within the range for wild cattle (discussed in section 5.1.2.2). All but four of the measurements from Afridar cattle (Figure 4) are smaller than the wild specimen. The four that fall within the range for wild cattle comprise one calcaneus (greatest length), one distal metacarpal (distal breadth), one distal metatarsal (distal breadth), and one proximal metatarsal (proximal breadth). Of the nine measured distal metapodials, six fall at -0.03 or higher. These bones could be interpreted as coming either from small wild cattle or from heavy or large domestic individuals. The proximal ends of metapodials fuse before birth, and the distal ends fuse early on in the life of cattle, at about 2-2.5 years (Silver 1969). After fusion, no further lengthening occurs, but increased body weight increases robusticity of the metapodials (Bartosiewicz et al. 1997:82). The bones of draught oxen will therefore manifest the heavier stature of the animal in the broadening and thickening (the breadth), rather than the lengthening of the bone. This broadening is due to the increased weight of the animal and, in the bones of the lower legs, is sometimes reflected in additional pathological broadening of articular surfaces due to strain of pulling loads (discussed in the next section).

The sample size of measurements from the Halif Terrace's cattle population is rather small (27 specimens); however, a few observations can be made on possible trends in the histogram (Figure 5). The four bones that fall well above the wild standard are two distal metacarpals (distal breadth), and two proximal phalanges (proximal breadth). While these four elements have been identified at the Halif Terrace as coming from *Bos primigenius*, it is of interest to note that they, like those from Afridar, are measurements taken on the breadth of foot bones, a possible indication of draught oxen. Two other bones in the sample of cattle measurements were identified in the laboratory as coming from aurochs. However, when plotted with the wild standard, these two bones do not stand out of the general population. These are a calcaneus which falls well within the domestic range at -0.09, and another distal meatcarpal which falls near the wild specimen, at -0.02.

The largely unfused assemblage of cattle bones from Shiqmim produced only 5 relevant specimens for comparison with the wild standard. All 5 measurements fall well beneath those from the wild aurochs, ranging from -0.16 to -0.07. A histogram is not given due to the small sample size.

5.3.2.3 Skeletal disorders on cattle bones

As the Chalcolithic period is thought to have seen the first use of cattle for draught in this area (Grigson 1995b:267), the nature and location of pathologies[43] on cattle bones from Shiqmim, Afridar, and the Halif Terrace are imperative evidence for the early use of cattle for labor. A number of cattle bones, especially noted in the Afridar assemblage, manifest signs of skeletal disorders on the metapodia and phalanges (see Tables 7 through 9). At Shiqmim (Table 7), one distal metacarpal (SHIQ93 114; Plate 3a) is a textbook example of pathology resulting from labor-induced stress on the bone. The trochlea is broadened from weight (from pulling or carrying heavy loads). Deep striations run planto-dorsally along the trochanter, a result of excessive and repeated rubbing of the distal end of the metacarpal against the proximal portion of the first phalanx. This metacarpal also manifests signs of severe palmar depressions (Plate 3b), a pathology found to occur on 44% of oxen metacarpals from Hungary and Romania (Bartosiewicz et al. 1997:43). This is the only cattle foot bone showing signs of trauma. While most skeletal deformations relating to draught occur in the distal extremities (the feet), less frequently affected

[42] The measurements from the wild standard are listed in Grigson (1989:81). She takes these measurements from Dgerbøl and Fredskild (1970).

areas are the shoulder and pelvic girdle (Bartosiewicz et al. 1997:13). The one other cattle bone from Shiqmim with pathological indications is a thoracic vertebra (Shiq93, Bone #859) with an irregular outgrowth on the tip of the dorsal spine[44]. Depending on which of the 13 thoracic vertebrae this spine represents, the exostosis can be associated with two different actions. The origin of the rhomboideus muscle is located on the neural spines of the first four thoracic vertebrae, and is involved in movement of the scapula (Weichert 1958:788). The tips of the neural spines of the posterior thoracic vertebrae are the origin for the spinalis dorsi muscle, involved in extension of the vertebral column (Weichert 1958:793). Strain-induced pathologies are especially manifested in the bones of the forelimb, suggesting the former. Regardless, in either case, the outgrowth on the spine might have to do with strain from pulling or carrying loads, possibly due to yoking.

At Afridar, 5% (8 out of 175) first and second cattle phalanges show moderate to severe deformations, manifested as exostoses often covering the entire body of the phalanx (Table 8; see Plate 4 for an example of this type of exostosis). Bartosiewicz (Bartosiewicz et al. 1997:44-53) notes that these same types of skeletal deformities occur frequently (usually over 50% of the sample) on first and second phalanges of draught oxen. A low frequency of 5% suggests that cattle herds at Afridar were not entirely made up of draught oxen, but that perhaps a small proportion of them were used intensively for draught[45]. Additional pathologies on cattle bones from Afridar include pitting on the distal end of a metacarpal, the proximal and distal ends of a metatarsal, and a large hole in the distal end of a tibia[46].

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[43] While an analysis of pathologies is most pertinent here in the case of cattle, all pathologies (including those on bones of other taxa) are listed and described in Tables 32-34.

[44] The outgrowth on the tip of the dorsal spine of this thoracic vertebra is *not* to be confused with the bifurcated spinal tip of the thoracic vertebrae of zebu (*Bos indicus*), sometimes found in this area. However, the extra bone growth may very well have to do with carrying extra weight, thus serving the same function as the bifurcated spine of zebu (which provides muscle attachments to support the weight imposed by the zebu's dewlap and shoulder hump.

[45] Based strictly on MNI counts, disregarding context, these 8 phalanges could hypothetically represent a minimum of one individual. While this is highly unlikely, given that the 8 bones come from different contexts and areas, caution must be taken when interpreting the results.

[46] Further examination suggests that this hole was actually made after the individual was killed, but while the meat was still fresh, perhaps for hanging the meaty portion of the leg from a hook. Two examples of the same have since been found in the faunal assemblage from the 1996 Halif Terrace excavations (identified by myself during the summer of 1999).

The only cattle bones exhibiting pathologies from the Halif Terrace (Table 9) are one second phalanx with lipping and one third phalanx with heavy swelling on its medial and lateral sides. Again, these are pathologies that can be associated with strain brought on by labor, old age, infectious pasture, or injury. Both of these bones come from the late EB IB (stratum IIb).

### 5.3.3 The role of equids in Early Bronze Age animal husbandry

#### 5.3.3.1 Species distinction

Results from section 5.2.3.4 indicate that the majority of the equids from Shiqmim, Afridar, and the Halif Terrace survived to adulthood. In addition, equid bones are often found articulating (see Plate 5) and not highly fragmented. These observations suggest that exploitation of equids involved some other product than meat, presumably labor. The use of equids for labor necessitates domestication, or at least taming. Therefore, the equid bones in this study probably all come from one of the two domestic equids, donkey (*Equus asinus*) or horse (*Equus caballus*). Distinction between donkey and horse in this study is made first on the basis of enamel patterns on the cheek teeth of equids. Enamel patterns on the majority of the equid teeth from Afridar and the Halif Terrace resemble those of ass (donkey/hemione) (see Plate 6a-6b for examples). One tooth from Afridar Area G, one tooth from Afridar Area F, and five teeth representing one maxilla from Afridar Area E have enamel patterns characteristic of horse[47]. These results indicate that a small percentage (less than 5%) of the equid teeth from all three sites come from horse.

To substantiate distinctions based on enamel patterns, all post-cranial elements with relevant measurements are compared with measurements from a wild onager (method described in section 3.3.3.1). The results are presented in Tables 32 through 34 and Figures 24 through 31. Nine of the equid bone measurements (7% of

[47] Drawings of these teeth are not available at this time, but will be provided in future analysis involving the Afridar equids.

the post-cranial sample from all three sites) fall well outside of the range for donkey, and more closely resemble measurements from horse (Figure 31). In sum, the majority of the equid remains from Afridar and the Halif Terrace most likely come from domestic donkey, a species undoubtedly used primarily for labor.

#### 5.3.3.2 Non-zooarchaeological evidence for equid exploitation

Clay figurines of donkeys carrying loads from this period (Ovadia 1992) emphasize the value of equids for transport during the Early Bronze Age. Depictions of equids carrying loads are not found in the Chalcolithic, suggesting the advent of habitual use of donkeys for transport in the Early Bronze Age. The occurrence of equid figurines is paralleled by a slight increase in equid remains at sites in the southern Levant in the Early Bronze Age (Ovadia 1992).

### 5.3.4 Dogs

Based on kill-off patterns and differential disposal, dogs at Shiqmim, Afridar, and the Halif Terrace are determined not to be primarily meat-providers. Dogs provide a different kind of secondary product in their capability to be pets or guard dogs for settlements or herds. These functions, particularly pets, are tied to ideological concepts of dogs as companions. Evidence that the inhabitants of Afridar placed this kind of meaning on (at least some of) their dogs is found in a complete dog burial from Area E. The presence of carnivores at the site (dog and fox) and the lack of disarticulation and gnaw-marks on the dog skeleton indicate that the dog was intentionally buried by humans, remaining untouched by scavengers. The bones are of a mature animal, evidenced by its permanent teeth and fully fused bones. The animal was found lying on its left side with its head resting on a juvenile donkey tibia which shows signs of having been gnawed. While no other distinct dog burials are found at Shiqmim or the Halif Terrace, the Halif Terrace has four partial to nearly complete dog and puppy skeletons in Early Bronze Age IA contexts (discussed in the next section).

## 5.4 Distribution and discard

### 5.4.1 Intra-site species distribution

The majority of the animal bone collection from Shiqmim was found in pits. Similar proportions of taxa were found in all contexts with the exception of one pit, L. 4160, which contained nearly one hundred percent sheep/goat bones (described in section 5.4.2.1). This is not surprising, as there were a large number of pits found at the site, and we would expect that these pits would be filled with debris, either from discard during occupation, or after the particular feature was abandoned. A characteristic feature of the architecture at Shiqmim, and of the Beersheva valley Chalcolithic in general, is its many subterranean and semi-subterranean rooms. A small number of bones came from the floors and fills of these subterranean rooms and the pits within them. Almost no bones were found in the tunnels and passageways associated with the subterranean rooms. The fact that so few bones were found in the subterranean rooms may simply result from natural processes of alluvial deposition after abandonment and not to cultural deposition through garbage disposal. During the inhabitation of the site, the rooms might have been used strictly for storage (perhaps of grains) and so would not have been filled with the refuse of food-processing activities. Similarly, if the underground rooms were inhabited by people, they would have been kept clean because household rubbish would only smell and attract flies and vermin in the confined area. The tunnels probably remained bone-free because they were used for coming and going, and not for food-processing or discard. The bones were found in similar proportions across the site (that is, most loci produced elements from all regions of the skeleton, both meat-bearing and non-meat-bearing). No distinct meat-processing or discard areas could be defined. Instead, the animal bone material across the site appears to be household debris, mostly found in pits.

A similar picture to that at Shiqmim is seen in the spatial distribution of taxa at Afridar. Excavations at Afridar E exposed over 90 pits (Golani 1997). Not surprisingly, the vast majority of animal bones was found in the "fill" of these pits, probably after the discontinuation of their use. Fewer bones were found in contexts defined as "habitational debris" above pits fills, and even fewer were from surfaces. An analysis of Afridar Areas E, F, and G by locus number and square indicates little variation in the spatial representation of various taxa across the site. An exception to this trend is a concentration of equid bones in L. 331 of Afridar Area E (described in section 5.4.2.5).

At the Halif Terrace, spatial analysis of sheep/goat, cattle, pig, and equid remains was attempted on a square-by-square basis for all Stratum II bones. Preliminary results indicate that bones from all four taxa are coming from similar areas. Unfortunately, the animal bone assemblage analyzed to date includes bones only from areas A and C of the Halif Terrace. The lack of bones from areas B and D limits a much needed site-wide comparison of animal bone remains. The animal bone assemblage analyzed thus far seems to be too small and incomplete to reveal any significant differences in the spatial distribution of animal bones. However, a larger assemblage covering all excavated areas might reveal finer differences that have not yet surfaced within this small assemblage.

### 5.4.2 Intra-site body part representation

The size of the assemblages in this study prohibits a full-scale spatial analysis (for example, over 100 of the loci from Shiqmim have fewer than 20 bones in them). This study, thus, analyzes specific outstanding trends in each assemblage on a species-by-species basis. Tables 35, 36a-36e, and Figure 32 describe the body part representation for the predominant taxa at Shiqmim, Afridar, and the Halif Terrace. Relative percentages of bones are presented using two methods. The raw bone counts (number of identified specimens) are presented in Table 35, grouped into five categories: head, back, upper forelimb, upper hindlimb, and feet. Tables 36a-36e present the raw data according to identified element. These data are then adjusted in Tables 36a-36e according to taxon and occurrence of each element in the body. The adjusted data are then grouped into the five skeletal areas described above and presented in the form of pie charts (Figure 32).

The general picture indicates that, since all body parts are represented, whole carcasses were present at the sites; that is, that animals were kept on or near the site, and were butchered and processed on site. A few general observations can be made on the body part representation data. Meat-bearing bones (back, upper forelimb, and upper hindlimb bones) make up at least fifty percent of all bones for sheep/goat, cattle, and pigs. Among equids, bones of the feet normally predominate. In the different phases of the Halif Terrace, there is a predominance of meat-bearing and foot bones in the EB IA and a predominance of head bones in the late EB IB (see Table 35). In general, foot bones are relatively more abundant among the larger taxa (cattle and equids). The poorer representation of these small foot bones among the smaller taxa (sheep/goat and pig) is probably due to the small size of the foot bones. Indeed, for all taxa phalanx 1 is on the whole better represented than phalanx 2 and 3, the smaller of the phalanges. Pigs have the highest proportion of head bones represented than any other taxon. This is likely due to the durable, thick composition of pig cranial bones and teeth. A more anomalous trend is seen in the distribution of cattle bones at Afridar G. Cattle upper hindlimb bones are twice as abundant as upper forelimb bones (see Figure 32). Additionally, among cattle feet from Afridar G, metatarsals are three times more abundant than metacarpals (54 metatarsals compared to 19 metacarpals; see Table 36d)[48]. This indicates a selection for cattle forelimbs which might not be due solely to preservation and retrieval, particularly considering the fact that the cattle forelimb has one more longbone than the hindlimb (and therefore we might expect a slight predominance of forelimb bones). This preference for hindlimb bones is also seen at Afridar F, though the sample size is much smaller (10 forelimb compared to 17 hindlimb) and the predominance of metatarsals over metacarpals does not apply (see Table 36c). More specific body part representation results by taxon are described in the following sections.

5.4.2.1 Sheep/goat

Sheep/goat body part representation is nearly identical at all three sites. Head and feet bones predominate, indicating the butchery, consumption, and discard of sheep/goat on site. The contents of one pit at Shiqmim, L.4160, produced a distinctive assemblage of sheep/goat bones. The contents of this pit included over 80 sheep/goat bones, one rodent bone and one hare bone. No bones of any other species were found in this pit. The bones in this unique assemblage make up the skeletal remains of at least four individual sheep/goat. One adult sheep is represented by long bones, and was over the age of 3-3.5 years at death (aged by a fused proximal tibia). A juvenile or adult goat is represented by articulating phalanges. Two fetal or neo-natal sheep/goat were also found, one represented by a nearly complete skeleton, and another by various entirely unfused hind leg bones. It is of interest that this unique assemblage came from the same pit as the complete anthropomorphic bone figurine described by Levy and Golden (1996) (Illustration 5).

5.4.2.2 Cattle

Body part representation among cattle shows some differences between the three sites. Cattle body part percentages from Afridar are significantly different than the figures from the other sites. Bones of the "head" category make up only 12% of the total cattle bones, compared to over 30% at the other sites. The difference is made up in the "feet" category, comprising nearly half of the Afridar assemblage (48%)[49]. The other two sites have on average 34% cattle foot bones. Finally, cattle

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[48] It is not possible to say whether the same applies to cattle fore- and hindlimb phalanges since individual phalanges were not attributed to anterior or posterior.

[49] The predominance of foot bones at Afridar might be due to retrieval strategies. Cattle foot bones are much larger and easily recognized than the small toes of sheep/goat. Indeed, the overall body part representation for sheep/goat "feet" bones in Table 35 is a lower percentage than at the other two sites, suggesting that this may well be the case.

hindlimb bones are twice as common as forelimb bones. Every other taxa shows a predominance of forelimb bones, most likely reflecting the quantification of five forelimb and four hindlimb bones[50]. The same is reflected in the equid bones from Afridar, where "feet" elements make up nearly one half of the assemblage, though this does not contrast so distinctly with the data for equids from the Halif Terrace.

5.4.2.3 Pig

An analysis of body part representation among pigs from Afridar shows a consistency of pig body parts in all areas, very similar to the proportions of sheep/goat parts. The fluctuations in the relative proportions of other species between Areas E, F, and G (Table 12) might result from some type of differential activity, perhaps having to do with the provision of pasture or secondary products. In contrast, the non-specialized nature of pigs would mean that they could be kept in small numbers in or near households, resulting in relatively equal numbers of pig bones in all areas. The toe bones of pigs are also poorly represented at Afridar. They comprise only 19% of the assemblage, whereas at the Halif Terrace they make up between 35% and 56% of the total pig bones. While the absence of small bones might result from poor preservation at Afridar, the abundance of fish bones at Afridar indicates relatively good preservation and attention to detail on the part of the excavators. Perhaps this difference between the pig assemblages at the Halif Terrace and Afridar is, rather, a factor of the small samples from the Halif Terrace.

5.4.2.4 Dog

Dog bones are often more complete than, and are not disposed of in the same way as, the bones of food animals. While there are some scattered remains of dogs at all three sites, they are the only taxon for which we find complete skeletons. At the Halif Terrace, four dog skeletons, two complete and two partial, were found in EB

[50] This study quantifies the radius and ulna separately (unless they are attached). This gives the "forelimb" category one additional element than the "hindlimb" category.

IA levels (stratum 3) of Area B during the 1994 excavations. Two of these skeletons represent puppies with predominantly unfused bones. The other two are adults with fully fused bones. While all the dog skeletons come from different loci, three of them were excavated in the same square (B19). The fourth was in an adjacent square (C19). This cluster of dog skeletons constitutes 24 of the 35 dog bones from the EB IA at the Halif Terrace. All of the dog skeletons came from "pit" and "fill" contexts, with no apparent burial cut. This method of discard stands in contrast to the buried dog from Afridar E (discussed in section 5.3.4) which appears to have been carefully placed in a pit with its head lying on a complete donkey bone.

5.4.2.5 Equid

Equid is represented at Shiqmim in the form of two forelimb bones (one a complete radius). At Afridar, equid feet dominate the assemblage, at 41% of the 70 total equid bones. Like those of dogs, equid bones are often found discarded differently than the bones of other domesticates used for food. Equid bone concentrations were found at both Afridar and the Halif Terrace. While equid bones are found in low numbers in most loci in all areas of Afridar, Locus 331 in Area E (the debris above a pit in the metal-working area) produced almost exclusively remains of equids. Of the 34 bones recovered, 32 are equid, the other two being a fragment of a cattle skull and a piece of a sheep/goat scapula. 27 of the 32 equid bones found in this locus were portions of mandibles and maxillae, including fragments of a nearly complete equid skull, representing a minimum number of 4 individual equids. The fact that the remains of equids are usually found in low numbers at sites and are sometimes found in articulation has been thought to indicate that they were used for purposes other than food (Grigson 1995b). This large concentration of equid bones in L. 331, which are in a differential deposition that the more common domestic animals which were processed for food, suggests that some kind of different activity was going on, outside of food preparation or normal discard. The almost exclusive presence of equid in this context is interesting, as is the relative paucity of skeletal areas other than the head. One smaller pit fill context from Afridar Area F (Locus 233) contains a similar concentration of large mammal bones. While sheep/goat bones dominate nearly every other context in Area F, Locus 233 contains 11 equid bones, 7 cattle, and 5 sheep/goat. The equid remains come from a minimum of two equids, and comprise mainly forelimb bones: a distal humerus, three radius fragments, two carpal bones, two metacarpal fragments, and two proximal phalanges. Two nearly complete metatarsals (a right and a left) are also included in this assemblage. The 7 cattle bones in Locus 233 include a pair of complete proximal phalanges.

The two equid bone concentrations at Afridar comprise clusters of bones from a particular skeletal area. An equid bone concentration at the Halif Terrace is of a different nature. A complete, articulated forelimb was found in Locus 65, a "fill" context from the EB IB (early or late phase is undetermined) (see Plate 5). The articulated bones, from the femur to the third phalanx, suggest that the leg was not discard from butchery for meat. Its complete articulation indicates, rather, that it was buried relatively quickly, before any carnivores or natural processes disturbed its original deposition. This find is paralleled by equid remains found associated with human burials and ceremonial contexts at Tell El-Ajjul (Middle Bronze II). There, a leg (fore or hind limb unspecified) of an ass was found and also a skeleton of a horse from which three legs had been removed by chopping (Bodenheimer 1960:184).

# Chapter 6

# Animals, Environment, and Society

Chapter 5 presented analytical results obtained when the methods described in Chapter 3 were applied to the data from Shiqmim, Afridar, and the Halif Terrace. Analyses focused on 1) determining the limitations of the local environment in shaping both the availability of species and human choices regarding husbandry practices; 2) defining patterns of animal production (specifically, meat use) in each period; 3) defining patterns of secondary products exploitation in each period; and 4) detecting areas of differential discard and distribution. This chapter synthesizes the results from Chapter 5 with the archaeological theory presented in Chapter 2. This chapter has three sections, dealing with each of the three research themes detailed in Chapter 2. Each section begins with a summary of the research objectives and predicted outcomes (for a full description, see Chapter 2). This is followed by a discussion of the results from Shiqmim, Afridar, and the Halif Terrace as they relate to the broader archaeological background to the Chalcolithic and Early Bronze I. Each section ends with a summary of the main findings, and how they support or contradict the predicted outcomes.

## 6.1 The Chalcolithic-Early Bronze I transition

### 6.1.1 Review of the research question

The Chalcolithic period ended in collapse, where there is a sudden and significant decline in the level of complexity that had been seen in such characteristics as some specialized ceramic production and large village settlements. The ensuing Early Bronze I period saw significant changes in architecture, settlement patterns, artistic endeavors, and metallurgy. However, it has also been proposed that a few threads of similarity can be traced between the two periods, suggesting a degree of continuity. Can elements of continuity or change be detected in the animal economy of the Chalcolithic and the Early Bronze I? Does zooarchaeological analysis provide any support for the present theories of the Chalcolithic collapse (detailed in Chapter 2)?

In Chapter 2, I predicted that the shift from the Chalcolithic to the Early Bronze I would manifest itself zooarchaeologically in a change from specialized, intensified, or centralized animal-related activities to smaller scale, household-based subsistence activities in the Early Bronze IA. I also predicted that evidence for the Chalcolithic collapse, if caused in part by instability from climatic shift, would be found in specific risk minimization strategies, such as broadening of resources, storage, increased mobility, and exchange. If the collapse involved commercial contact with Egypt, we would see evidence for increased transportation activity and increased production of goods for trade.

### 6.1.2 Chalcolithic and Early Bronze IA animal economy

#### 6.1.2.1 Evidence from the Chalcolithic (Shiqmim)

Results of taxonomic richness show that Shiqmim has the lowest diversity of taxa within its assemblage. The very low numbers of hunted animals at Shiqmim indicate that the inhabitants of the site relied on domestic animal husbandry, and did not rely on hunting to supplement their diet. While the low diversity of taxa might simply be a result of the local environment, the northern Negev being arid and less "rich" in taxa than other areas, the small proportion of wild animals might also reflect the long-term nature of the settlement, where the inhabitants came to rely almost exclusively on their domestic stock, having exploited the surrounding wild resources over many years of occupation. The lack of access to a diverse selection of wild and domestic animals (including pigs, who were not available in the local environment) could be a factor which led them to devise an efficient and regulated way of exploiting their domestic animals. Although wild animals such as gazelle were in the area, the Shiqmim inhabitants chose not to hunt them habitually, but rather to rely nearly exclusively on their domesticates, sheep/goat and cattle. It has been suggested that animal husbandry was very important for subsistence at Shiqmim because of the small amount of pulses found at the site (Kislev 1987:264). This factor could have also contributed to the very specialized system of animal exploitation at Shiqmim to insure a stable supply of proteins.

Swollen roots and calculus build-up on sheep/goat teeth are more prevalent at Shiqmim than at Afridar and the Halif Terrace, suggesting that the animals of Shiqmim lived in a harsher environment or more crowded conditions, making them more susceptible to periodontal disease. We would expect to find swollen roots and calculus build-up more prevalent among older individuals. The higher occurrence of swollen roots and calculus build-up at Shiqmim is interesting given that the sheep/goat population was, overall, younger than that at the other two sites.

Large animals are difficult to keep in a hot, arid environment. The low percentage of cattle[51] and the higher proportion of goats in the herds at Shiqmim (though in meat weight, the 12% cattle at Shiqmim still accounts for more meat than the sheep/goat) reflect the arid environment in which the site was located. However, the smaller size of sheep/goat at Shiqmim (Figure 2) cannot be said to be related to environment alone. Selective husbandry practices could contribute to these discrepancies. For example, given the higher number of unfused elements at Shiqmim, the size difference might simply result from the predominance of juveniles killed in a milk-focused exploitation strategy. We might also see a smaller overall size if the Shiqmim herds were dominated by adult females and young males, also resulting from a milk-focused strategy. Finally, a smaller overall size might be related to the sheep to goat ratio at Shiqmim which is nearly 1:1. If goats were smaller in size, their presence in higher numbers in the Shiqmim assemblage might be reflected in smaller overall measurements[52]. The same might apply to cattle, where the average size of cattle at Shiqmim is, on the whole, smaller than that at Afridar (Figure 3). This might

[51] It must be kept in mind, however, that in meat weight ratios (Clark and Yi 1983), the 12% cattle bones at Shiqmim account for more meat than the 85 % sheep/goat bones.

result from environmental constraints, where smaller individuals survived better in Shiqmim's arid environment. However, the smaller overall body size might reflect a predominance of juvenile males and older females in the death assemblage. A kill-off such as this would reflect a focus on milking, fitting with the importance of sheep/goat milking and the milk-related ceramics and figurines.

There is a much lower instance of cut marks in the assemblage from Shiqmim than that from Afridar. Shiqmim's paucity of cut marks cannot be explained by poor preservation. Given the relatively poor preservation at Afridar, we would expect to detect far fewer cut marks there than at Shiqmim, where preservation was much better[53]. This infrequency of butchery marks at Shiqmim can be seen as evidence for more skilled or specialized butchers, suggesting a certain level of standardization in butchery[54] at Shiqmim. In contrast, the evidence suggests that the people at Afridar were butchering animals in a less specialized and more haphazard way, perhaps on a household basis.

The sheep/goat ratio, together with the age data from sheep/goat, suggest that the inhabitants of Shiqmim practiced a herd management strategy focused on assuring both meat *and* milk. According to Redding's model for an environment such as at Shiqmim, we would expect a sheep/goat ratio of 5:1 for a goal of protein and energy maximization, and between 1.7:1 and 1:1 for a goal of herd security (Redding 1984). The sheep/goat ratio of 1.2:1 at Shiqmim suggests that, in this arid Negev environment, the inhabitants of Shiqmim aimed their sheep and goat exploitation at herd security, or the constant maintenance of a breeding population, the minimization of losses due to environmental changes or epidemics, and the assurance of a secure source of meat *or other products*. Sheep/goat herd management at Shiqmim, thus, aimed at securing the sustainability of the herd and *assuring*, rather than maximizing, meat or secondary products production.

[52] The body of measurements from known goat bones is small, but the data seem to indicate that goats were generally smaller than sheep (see Figure 2a).
[53] However, the absence of cut marks at Shiqmim might also be due in part to the predominance of juveniles, whose unfused bones facilitate disarticulation and might result in fewer cut marks.

Evidence from mandibular tooth eruption and epiphyseal fusion stages indicates a high kill-off in the first year, closely resembling Payne's kill-off where milk is the objective (Figure 9). Of the three survivorship curves given by Payne, Shiqmim's most closely resembles a pattern where milk is the primary objective. The kill-off of many lambs and kids in their first year of life might also reflect a less stable environment, where they had to be killed in order for the flocks to survive the winter. Whether the need to do this led to a specialized milking strategy, or vice versa, cannot be determined. The evidence remains that the kill-off at Shiqmim indicates meat and milk with no indication of *selection* for wool. Because the inhabitants of Shiqmim intensively used sheep/goat, it stands to reason that wool and hair were convenient by-products of their herding activities. Nevertheless, the people of Shiqmim probably did not shape their herding strategies to maximize wool and hair production.

Intensified milking in Chalcolithic may imply a shift in the ideology regarding women. Ethnographic evidence from Turkey indicates that milking and the making of milk products is commonly the realm of women (Delaney 1991:246). Milk-related figurines from the Chalcolithic, such as the "Women with Churn" from Gilat (Alon and Levy 1989), link milk products with women. The involvement of women in this specialized practice in the Chalcolithic suggests that the role and status of women might be different than areas where milking was not so intense.

Special deposits of animal bones hint at some role for animals in Chalcolithic ritual. Excavations at Shiqmim found one pit (Locus 4160) in which 80 sheep/goat bones were found, representing one adult, one juvenile, and two newborns (discussed in section 5.4.2.1). This unusual assemblage consisting of articulated individual sheep/goat bones, no cattle bones (which are common in all other contexts), and an anthropomorphic bone figurine, possibly resulted from some kind of ritual activity. The Chalcolithic site of Gilat had a circular "burial monument" which contained nine

[54] Zeder (1991:156) sees a decrease of cut marks and their focus on particular areas of the carcass as indicating standardized butchery in the ABC and later TUV phases at Tal-e Malyan (3200-2900BC).

human skeletons buried above a layer of animal bones (Alon and Levy 1989). However, a lack of data pertaining to the relationship of animal bones to features and architecture at other Chalcolithic sites in the southern Levant makes it difficult to make inter-site comparisons. Newborn sheep/goat (especially sheep) have a high mortality rate (Lancaster and Lancaster 1991). Zeder cites modern ethnographic data which indicates that, in a dry year, up to 50% of lambs and kids might be lost from a herd (Zeder 1990). If the environment around Shiqmim became unfavorable for parts of the year, this deposit of whole or partial sheep/goat might represent just such a die-off. Nevertheless, the importance of sheep/goat husbandry and milking at Shiqmim might have placed more significance on the death of newborn lambs and kids. The fact that these animals do not seem to have been consumed in the same way as the other food animals at Shiqmim suggests that they might have had some special or ritual significance, particularly in light of the anthropomorphic bone figurine found in the same context (Illustration 5).

Sacrifice of domestic animals was a common and documented practice across the Near East since the 3rd millennium BCE (Bodenheimer 1960:203). This pattern of ritual seems to also apply to the southern Levant. Hesse and Wapnish interpreted the partial remains of a gazelle skeleton in a tomb shaft at the EB IA Bab edh-Dhra cemetery as a deliberate deposit, where the skinned animal was possibly associated with some kind of sacrifice or ceremonial meal (Hesse and Wapnish 1979). Horwitz interprets caprovine remains in tombs from EB IV sites in the Refaim Valley as offerings placed in the tombs with the human burials (Horwitz 1989). She suggests that the selection of sheep/goat for offerings, in spite of the other available taxa, stresses their importance and availability in the economy. Similar deposits were found by Grigson in her analysis Shiqmim faunal material (1987 excavations) (Levy et al. 1990). She describes "special deposits" of animal bones, including a sheep skeleton and a cow skeleton in a large bell-shaped pit, and another sheep skeleton in a smaller pit. Another deposit contained the fore and hind phalanges of a sheep/goat, a polished cattle scapula, and a polished sheep/goat radius. The figurine from the 1993 excavations (Illustration 5) was also made from a polished cattle scapula. These ritual deposits may indicate that the Chalcolithic people attributed important and probably sacred symbolism to their domestic animals. Chalcolithic artistic representations further support this inference.

In sum, the small stature of the sheep/goat population (possibly indicating females and young), together with the high number of unfused bones, the high kill-off of young indicated by mandibular tooth eruption and wear, and the ceramic and artistic evidence for milking in the Chalcolithic all point to a higher focus on milking than in the EB IA. A low occurrence of cut marks suggests the presence of skilled butchers, while an even distribution of skeletal areas of the predominant taxa indicates that butchery, consumption, and discard were taking place on site. Evidence points to specialized husbandry practices at Shiqmim regarding sheep/goat meat and milk production. While some degree of movement of sheep/goat herds certainly occurred, the present evidence indicates that specialized activities were taking place within the settlement. This intensive milk production may indicate some level of milk production beyond the needs of a typical household. In this light, the inhabitants of Shiqmim may have used some surplus milk products in a local exchange network, since milk products are more amenable to local, rather than long-distance, exchange. Such exchanges may have served as a means of risk reduction in this marginal environment, where people may have sought to maintain exchange ties with their neighbors to buffer against food shortages. Perhaps, given the hints of great symbolic importance associated with domestic animals and milking, such exchanges took place under the rubric of cultic institutions as suggested by Levy (1995). While this evidence is by no means conclusive, the relationship between milking and cult in the Chalcolithic deserves further investigation.

#### 6.1.2.2 Evidence from Afridar (EB IA)

All areas of Afridar show a similar taxonomic richness, which is higher than that at Shiqmim and in the EB IB of the Halif Terrace. The wider spectrum of taxa exploited at Afridar might reflect the shorter-term occupation of Afridar, compared with Shiqmim. The greater number of wild animals at Afridar indicates a higher hunting component to the subsistence base than at Shiqmim.

The presence of pig bones at Afridar is likely related to the local environment; their high numbers (15% in all areas) in relation to other Early Bronze Age sites in the area attests that the coast was well-suited for pig breeding and maintenance. However, it is likely that their presence heralds a number of other social and economic implications in addition to the environmental explanation. Pigs imply a certain degree of sedentism and the use of certain animals by households as personal food items (Grigson 1995b; Zeder 1996). It has been suggested that, in situations where agricultural activities involve intensive grain production, pigs compete directly with humans for food (Redding 1991). Redding proposes that pigs cannot be kept in any great numbers where agriculture involves raising grains unless one of the three following applies: 1) pigs are kept away from grain fields and there are other food sources for pigs; 2) raising grain is secondary, and residents are primarily engaged in raising sheep/goat, cattle, fishing, or orchard crops; 3) sufficient land is available to produce a surplus to feed pigs (Redding 1991). Pig-keeping is therefore better suited for horticultural activity.

Finds of olive stones, olive wood, and grape pips at Afridar and other sites along the coast indicate the important, perhaps predominant, role of these products in the agriculture of the EB I in this region (Gophna 1997). The stable numbers of pigs spatially at Afridar (15% across the board) might have to do with the nature of pigs as strictly a meat animal. Any focused or specialized animal husbandry activities would involve the care of sheep/goat, cattle and perhaps equids; that is, those animals from which secondary products might be procured. We would thus expect pig numbers to remain stable, while fluctuations might occur in other taxa requiring a more formal management strategy for secondary products. The consistent proportion of pigs in all three areas of Afridar is perhaps indicative of a domestic use of the pig as a private food item.

Pigs in ancient Egypt are thought to have been maintained by individuals and not subjected to the same degree of state control as were cattle, sheep and goat (Redding 1991). This limited state role in pig rearing may result from the difficulty in extracting any surplus from intensive pig production, since they provide little in the way of secondary products (Redding 1991). Pig husbandry is well-suited to settings with little intervention by any central authority, as was the case in the post-collapse EB IA in the southern Levant.

The domestic donkey is thought to have been introduced to this area during the Early Bronze Age. Its presence at Afridar thus reflects human action—bringing donkeys to the area. This is not to say that wild ass (*Equus africanus*) herds were absent from this region. However, the present evidence (detailed in section 5.2.3.4 and section 5.3.3) does not infer wild ass remains at Afridar or at the other two sites under consideration here, suggesting that wild ass was not hunted for food. The role of donkeys in the Early Bronze Age southern Levant is discussed in section 6.3.

The larger average body size of Afridar cattle (as compared to Shiqmim) is likely a factor of local environmental conditions (Figure 3). The animals from the coastal sites had year-round access to more nutritious and conveniently-located pasture, and thus were slightly larger (heavier) than the animals inland in the desert margin, who had less nutritious and abundant locally-available pasturage. However, we must keep in mind that the average body size reflects the herd composition as well. As previously mentioned, a predominance of juvenile males and adult females might account for the overall smaller size of the Shiqmim cattle. Likewise, perhaps at Afridar we are seeing an increase in average size due to the presence of oxen, rather than the hunting of wild cattle. Numerous pathologies on the bones of cattle feet at Afridar can be interpreted as evidence for the use of the Afridar cattle for draught (see Plate 3 and Plate 4). In that case, the larger size of the Afridar cattle might be due to a preference for males for draught; whereas, in the Chalcolithic, the people might have used young males for meat and kept females for breeding and milking. Most Early Bronze Age zooarchaeological studies claim that cattle were used for draught, presumably throughout the Early Bronze Age. Evidence from EB IA Afridar supports this to a certain extent, while evidence from EB I Halif Terrace provides little evidence for draught, as will be discussed in section 6.2.

Survivorship based on mandibular tooth eruption and epiphyseal fusion stages from the Afridar sheep/goat indicates a meat-focused kill-off (Figure 12 and 13). The majority of animals were killed by about three years of age, the point of maximum growth where the cost exceeds the benefit of maintenance to older years (unless, of course, maintenance involved the assurance of some other product). Sheep/goat herd composition data provide more insight into the use of sheep/goat. The sample sizes from Areas E and F are small; however, the more reliable sample from Area G (162 bones distinguished as sheep or goat) provides a ratio of 4:1. A herd composition such as this reflects an environment that was sufficiently temperate and wet to provide a suitable habitat for sheep. Redding (1984) also proposes that, as the range of activities moves away from agriculture, the sheep/goat ratio will approach 5:1. While a high proportion of sheep suggests wool exploitation, the age data do not support a focus on wool production. However, wool exploitation might have occurred on a small-scale among the older animals kept for breeding. Thus, the sheep to goat ratio at Afridar might reflect the wetter environment or a less intensive focus on agriculture than in other periods.

The wide spectrum of cattle measurements at Afridar is probably a reflection of a more diverse use of cattle at Afridar than at Shiqmim, where the cattle are generally smaller and show a more restricted range in size[55]. At Afridar, the size variation may reflect differences between milk animals and labor animals, and between males, females, and castrates. If the larger bones in the sample were mainly from wild cattle, we would expect a variety of elements, not just distal metapodia. The distal breadth of the weight-bearing bones will increase as an animal's stature becomes more robust. Growth may or may not be seen in bone length, depending on the animal. If these were cattle selected for draught, they would not necessarily be tall, but would certainly be robust (whereas wild cattle would be larger all over). Therefore, the large metapodia from Afridar may in fact reflect larger, more robust domestic animals used for labor.

Pathologies on foot bones of cattle from Afridar indicate that some of the cattle were used for labor. While these types of chronic conditions can result from old age or injury, the consistent occurrence of such pathologies can be attributed to the use of cattle as draught animals (Bartosiewicz 1997:123). However, the low frequency of pathologies indicates that such use for labor was not very intensive. Cattle teeth, however, do not show the types of periodontal disease often noted on sheep/goat teeth. This probably reflects diet, smaller numbers of cattle (less sharing of pasture), and perhaps to the better treatment of cattle if they were used for labor. Ethnographic accounts indicate that attitudes toward draught cattle are better than for milking cows or bulls (Bartosiewicz et al. 1997:120). Figurines of draught oxen from the EB I might, then, reflect respect for the animals.

6.1.2.3 Evidence from the Halif Terrace (EB IA)

The faunal assemblage from the EB IA at the Halif Terrace is small (325 identified specimens); however, some general observations can be made from the results. The richest spectrum of taxonomic diversity at the Halif Terrace occurs in the EB IA (Table 1). The EB IA sees a higher proportion of wild animals exploited than in the subsequent phases (the Early and Late EB IB) (see Table 13). The EB IA also sees the highest proportion of equid bones, which decreases over time from 13.2% in the EB IA to 6.1% in the Late EB IB. Kill-off patterns for sheep/goat in the EB IA at the Halif Terrace (Figure 14) suggest that meat was a primary objective. However, the absence of specimens from age category "D" indicates some intentional maintenance of animals between 1-2 years of age. Whether these animals were simply not killed, or whether they were sent away from the site, cannot be

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[55] The more restricted size range for the Shiqmim cattle might be a simple fact of the limited sample size.

determined. While the EB IA kill-off is based on a very small sample size (16 specimens), the focused strategy that sees an absence of "D" age individuals is one that surfaces again in the Late EB IB (Figure 18). This tentative evidence indicates some continuity in animal management throughout the Early Bronze I at the Halif Terrace (discussed in section 6.2).

### 6.1.3 Continuity and change in the Chalcolithic-Early Bronze I transition

#### 6.1.3.1 Zooarchaeological evidence for change

Shiqmim represents the lowest taxonomic diversity of the assemblages in this study. The low number of different taxa exploited is likely related to the more arid environment of the northern Negev, which provided the inhabitants of the site with a narrower resource base from which to draw. As predicted, the EB IA saw a broadening of resource exploitation with regard to animals. The assemblage from Afridar Area G represents the broadest taxonomic diversity, followed by areas E, F, and the EB IA at the Halif Terrace.

Whether access to a broader range of animal resources was intended with the Early Bronze I move into different areas or whether it was a convenient result of the move cannot be determined. In either case, the environment of the Early Bronze IA settlements provides a wider range of wild taxa and a more manageable setting in which to exploit domestic animals (perhaps requiring less complex strategies for managing animal resources than at Shiqmim). At Tell Halif, Zeder (1996:27) sees a broadening of the Late Bronze Age resource base, an increase in high yield, easy to raise pigs, and the opportunistic and focused kill-off of sheep/goat as indications of an isolated community reliant mainly on its own resources for survival. Findings from Afridar tend to follow the same trends. Afridar has a broad resource base and a high proportion of pigs (see Table 12). The kill-off of the majority of sheep/goat by 2-3 years of age indicates that meat was the primary objective (see Figures 9 and 12). Likewise, the EB IA at the Halif Terrace, while comprising far fewer pigs than

Afridar, has the highest proportion of pigs compared to the other two (later) periods at the Halif Terrace (see Table 13).

While the very high numbers of pigs at Afridar most likely reflect the wetter environment on the coastal plain, their extensive exploitation necessarily affects the way people perceive and organize their livelihood. The absence of pigs, a highly productive and convenient meat source, at Shiqmim may have necessitated the formation of a more organized system of animal production to assure a reliable source of meat. At Afridar, the more lush environment and wide spectrum of animals, together with the shorter occupation of the sites, allowed for a more varied subsistence, perhaps on a more household or individual-based level. Additionally, the high numbers of pigs at Afridar would fit well with an involvement in horticulture. This emphasis on horticulture at Afridar is substantiated by a high sheep/goat ratio (4:1) which suggests a low involvement in agriculture (Redding 1984). In contrast, the lower numbers of pigs at the Halif Terrace might indicate more involvement in agriculture, a system in which it is more difficult to keep pigs (Redding 1991).

Contrasting evidence from Chalcolithic Shiqmim and from the EB IA at Afridar and the Halif Terrace suggests more intensive milking in the Chalcolithic than in the EB IA. There appears to be a higher proportion of juvenile sheep/goat in the Chalcolithic in general, compared to the Early Bronze Age (Horwitz and Tchernov 1989), though results need further substantiation. It thus appears that some of the earliest specialized milking occurred in the Chalcolithic, at least in the northern Negev area. Sheep/goat exploitation in the EB IA appears to be meat-focused (not on any scale intensive enough to call it specialized), though a predominance of sheep at Afridar suggests that a small degree of wool (and presumably milk) exploitation might have been practiced.

The donkey is an important element of the animal economy at EB IA Afridar. Equid bones (predominantly donkey, with a few horse bones) comprise a high proportion of the assemblages from Areas E and F (20.9% and 14.9%, respectively).

A significantly lower proportion in Area G (1.7%) suggests that: a) equids were kept in areas E and F, but not in Area G; or, b) equids were used in Area G, but their remains were disposed of in areas E and F after those areas were abandoned. Unfortunately, until a clearer picture of the chronological relationship of these three areas can be drawn, the spatial differences in equid bones are difficult to interpret. Nevertheless, the high numbers of equids, presumed to be predominantly domestic donkeys (see section 6.3.3), indicate a significant change in the animal economy that began in the EB IA. Donkeys facilitate mobility and trade: their incipience in the EB IA certainly brought opportunities for a level of contact never before possible.

In sum, differences can be detected in the animal economy of the Chalcolithic and the EB IA. These differences indicate a substantial shift both in the types of animals used and in the mode of exploitation and include a broadening of animal resources and a decrease in specialization (specifically in milk use). High numbers of pigs and donkeys in the EB IA at Afridar imply both sedentism and increased transportation capacity, presumably for exchange. The proposed Chalcolithic strategy of local milk product exchange collapsed and in the EB IA gave way to a strategy of animal resource diversification, and perhaps long-distance exchange, facilitated by the recently domesticated donkey. These changes suggest shifts in risk-reduction strategies that may have been employed to buffer against stress brought on by the end of the Chalcolithic.

6.1.3.2 Zooarchaeological support for theories of change

Joffe's (1993) proposed shift in the organization of power finds a significant amount of zooarchaeological support. With a shift from symbolically-weighted goods to commodities, I predicted an increase in wool production in the EB IA to meet increased demands for commodities. There is no evidence for an increase in wool at Afridar or the EB IA at the Halif Terrace. In fact, specialized activities regarding sheep/goat (specifically, milking) appear to decrease from the Chalcolithic to the EB IA.

The use of donkeys in the EB IA, however, indicates that some level of movement, possibly involving the exchange of commodities outside the region of the southern Levant (most likely Lower Egypt), characterized the EB IA. The high numbers of donkeys at EB IA Afridar and the Halif Terrace suggest that the movement of people or commodities were indeed important in the EB IA. However, the lack of evidence for wool production in the EB IA indicates that wool was not a significant component of commodities exchange.

The model put forth by Hanbury-Tenison (1986) suggested both an ideological change and a change in lifestyle, from corporate to private ownership. While a change in ideology finds little support zooarchaeologically, it is indicated by a shift in the subject of figurines from the Chalcolithic to the EB I. Figurines from the Chalcolithic depict sheep/goat and women holding churns, indicating the importance of sheep/goat and of milking in the Chalcolithic. The Early Bronze I saw a near disappearance of artistic endeavors. However, the few figurines from the EB I depict yoked oxen and donkeys carrying loads. This implies a significant shift in ideology regarding the animal economy. The importance of donkeys as a means of transport, trade, and contact certainly had a profound effect on ideology in the Early Bronze I. The high proportion of equid bones in EB IA contexts supports the increased importance of donkeys in this period.

A shift from corporate ownership in the Chalcolithic to private ownership in the EB IA finds tentative support in an increase in butchery marks in the EB IA. As mentioned above, butchery marks are the result of careless or inexperienced butchery. A dearth of butchery marks at Shiqmim might indicate specialized butchers working in a corporate setting during the Chalcolithic. However, the data might also have nothing to do with ownership, but rather with meat distribution practices involving specialized butchers in a redistributive or market setting. A review of the spatial distribution of taxa and body parts reveals few detectable differences between contexts in the Chalcolithic or the EB IA (except for the few concentrations discussed below). In other words, there is no evidence for contexts with particular meat cuts, taxa, or ages that might point to corporate ownership and redistribution in the Chalcolithic. From the few spatial analysis that have been attempted at other sites (discussed in Chapter 2), this generalized scatter seems rather typical of faunal material in this period. The lack spatial variation cannot, therefore, be taken as evidence for individual ownership in either period. It seems that, at least in this case, there is little evidence with which to substantiate corporate versus private ownership through zooarchaeological data. Concepts of corporate and private ownership merit further research, particularly in later periods when these types of ownership might be demonstrated more convincingly through other lines of investigation (for example, texts). In those cases where it can be identified by other methods, zooarchaeological data might prove more enlightening.

Levy proposes a system of risk management and gift-giving to describe the Chalcolithic social organization (Levy 1995). Risk management in the Chalcolithic involves the development of a social institutions to regulate pastoral activities, of which milk products and iconography are a component. A focus on sheep/goat and milking in the Chalcolithic provide evidence for the importance of milk products. A high focus on sheep/goat for meat and milking, based on their numbers (88% of the assemblage) and focused kill-off before two years of age, suggests a specialized strategy of sheep/goat husbandry. This strategy probably developed in part out of the limitations of the local and social environment, and might have played a part in some type of risk management system to buffer against environmental fluctuations and limited pasturage.

The special deposit of four sheep/goat partial skeletons at Shiqmim might indicate some kind of communal ritual or feasting that can be associated with gift-giving and the maintenance of Chalcolithic elites. However, much more evidence for this type of behavior is needed if we are to interpret deposits such as this as a component of Chalcolithic gift-giving. Further tentative evidence for gift-giving in the Chalcolithic at Shiqmim is found in the small number of animals with prestige potential. The two horse bones at Shiqmim can be interpreted many ways. If they are from domestic horses, they would have been a prestigious animal to keep. In light of the absence of other equids at Shiqmim, horses would have been rare and extremely useful. If the bones are from wild horses, they appear to have been equally rare, and significance would have been given to their meat, hides, and the difficulty in hunting them.

The corpus of churns, cornets, and sheep/goat figurines carrying churns and cornets suggests an increased significance placed sheep/goat milking during the Chalcolithic. Milk and milk products might have been a component of Chalcolithic gift-giving. If they were a part of Chalcolithic symbolism, the shift from symbol-based to commodity-based exchange in the EB IA would not necessarily include perishable milk products (especially if this shift in exchange involved Egypt, implying movement of goods over long-distances). A change in the value placed on milk products might result in the collapse of a milk-based ideological system. This would be reflected in a change in the sheep/goat kill-off, as indicated by the data from this study. The evidence therefore provides some support for Levy's theory and merits further exploration.

A final mention must be made regarding the nature of specialized animal activities in the Chalcolithic and Early Bronze IA. Evidence from Shiqmim suggests specialized milking, possibly as a component of a Chalcolithic gift-giving system. In such a system, it is of interest to ask who produced milk products and under what demand were they producing them. Milk and milk products are usually seen as products of the subsistence economy in the Near East. They would therefore be considered "utilitarian" (not prestige products) and, when specialized, can be associated with independent specialization. However, their association in the Chalcolithic with special or ritual ceramics and figurines indicates that milk products themselves might have held some symbolic, prestige, or ritual value. These types of prestige items are more often associated with attached specialization. There is, as yet, no evidence from Shiqmim for a centralized institution to oversee specialists or keep animals. It is likely that, if milking specialists existed at the site, they were noncentralized attached or independent specialists working from their households or in some kind of semi-sedentary capacity.

### 6.1.4 The Chalcolithic collapse

Zooarchaeological evidence points to disintegration of earlier practices and instability in the Early Bronze IA. All the EB IA assemblages in this study are the most diverse, in terms of general taxonomic richness (Table 1). Shiqmim is the least diverse, indicating a narrower resource base. While this probably has something to do with the environment, various lines of evidence indicate that the inhabitants of Shiqmim adhered to a specialized strategy for sheep/goat management. A broadened resource base in the EB IA suggests a mixed and diverse economy, with little indication of specialized activities. These zooarchaeological indications confirm Joffe's proposal that the EB IA saw a collapse in the socio-political superstructure of society (Joffe 1993:37). However, Joffe's proposed "attenuation of structures" model for the Chalcolithic collapse is not so much an explanation for collapse as it is a symptom of collapse.

We will therefore move on to discuss the two other theories for collapse, environmental change and commercialization. If a climatic fluctuation were involved in the Chalcolithic collapse, we would expect to see changes in the animal economy in response to increased instability brought on by the changes at the end of the Chalcolithic. Risk management strategies to cope with instability include broadening resource exploitation, increased mobility, storage, and trade (Halstead and O'Shea 1989). As already discussed above, the EB IA at Afridar and the Halif Terrace has a broader resource base than the Chalcolithic or the EB IB. This might have been a way of coping with instability brought about by a climatic fluctuation.

Increased mobility finds evidence zooarchaeologically in the high numbers of equids in the EB IA at Afridar and the Halif Terrace, as opposed to 0.1% at Shiqmim. In contrast, the high proportion of domestic pigs at Afridar (fewer at the Halif Terrace) indicate a low degree of mobility.

There is little indication of storage of animal products, although the higher number of cut marks on bones at Afridar compared with those from Shiqmim might result from slicing meat that had been dried/salted on the bone.

Increased trade as a risk management strategy finds support, again, in the presence of donkeys at EB IA sites. If commodities such as wool or milk were components of this trade, there is no indication of increased production in the EB IA. However, trade may not have involved these types of items. Horwitz and Tchernov (1989) emphasize the importance of remembering that the presence of certain species in an assemblage may indicate trade rather than environment. A complete half-mandible of a lion (Plate 7) from Afridar Area G and a fragment of a crocodile maxilla, also from Afridar Area G might represent just such traded items. The well-preserved lion mandible may have been brought to the site in a skin. While crocodile probably lived in the Afridar area at this time, a maxilla fragment also suggests that it arrived at the site attached to a skin. These rare species might represent commodities for trade in the EB IA[56].

In sum, climatic fluctuation finds some support zooarchaeologically. However, these same results can be applied to other explanations of the Chalcolithic collapse, so we must interpret them with caution. As shown below, the same results, together with other evidence, provide stronger support for the commercialization model.

The commercialization theory sees Egyptian interest in commodities from the southern Levant as contributing to the breakdown of the Chalcolithic way of life. Interest from outside the southern Levantine Chalcolithic system would change the significance of objects that, in the Chalcolithic, were weighted with symbolic meaning. The "commercialization" of the southern Levant in this way led to the collapse of the Chalcolithic politico-economic order (Joffe 1993:37) in light of new

[56] If trade were the case, the lion and crocodile specimens would falsely inflate the calculation of taxonomic richness at Afridar G (Table 1). However, when these two taxa are removed from the calculation, the taxonomic richness at Afridar G comes out at 1.97, a figure that falls within the diverse spectra for the EB IA, and higher than either the EB IB or the Chalcolithic.

international opportunities and influences. We would expect to find zooarchaeological evidence for commercialization in the presence of equids for transport and exchange, and a focus on particular species or products for export. We might also expect to see a change in animal-related products or activities that were tied to the Chalcolithic politico-economic order (such as milk production).

The EB IA sites used in this study have a high proportion of equids. Afridar shows a high number of equids in two of the three areas. The Halif Terrace has the highest relative proportion of equids in the EB IA, and equid numbers decline into the Late EB IB. As both of these sites were within the Egyptian sphere of contact during the Early Bronze I, it is not unlikely that equids were a major component, facilitator, or even instigator of this increased contact. Commercial contact that was significant enough to disrupt the ideology and instigate the collapse of societies that had persisted in one area for nearly a millennium had to be fairly intense. If this commercial contact involved transporting copper and other commodities to Egypt, it necessitated the use of pack animals. There are only two equid bones in the assemblage from Shiqmim. Additionally, those two bones come from horses, whose domestic status is disputed. The evidence from Shiqmim, a large Chalcolithic site, suggests either that equids were not involved in the proposed early commercial contact between Egypt and the southern Levant, or that their remains have yet to be found.

Evidence for export of particular species or products is found, again, in equids. If equids themselves were a commodity, the high proportion of equids at Afridar and EB IA Halif Terrace suggests intensive exchange. Little evidence is found for production of other goods, such as wool in the EB IA at these sites. However, another potential commodity in short-distance trade is milk, which seems to have been highly valued in the Chalcolithic. The milk-related ceramics and figurines of the Chalcolithic disappeared in the EB IA. Likewise, zooarchaeological evidence indicates a decrease in milking in the EB IA. If milk and milk products were a component of symbolically-weighted, short-distance exchange during the Chalcolithic, it appears that this disappeared in the EB IA.

In place of milk-related ceramics, EB IA artistic endeavors mostly involved donkeys or cattle (Epstein 1985; Ovadia 1992), suggesting a symbolic importance placed on transport. The shift in symbolism to draft and pack animals (suggested in EB IA figurines) indicates the importance of transport and mobility during this time. High numbers of equids and the occurrence of pathologies on the foot bones of cattle from Afridar provide zooarchaeological support for the use of these animals for labor or transport. Long-distance trade, facilitated by the donkey, and involving increasing contact with Egypt would not likely include such perishables as milk products. Zooarchaeological evidence therefore supports a socio-political change involving a decrease in the specialized production of more symbolically-weighted milk products and related objects (figurines, churns, cornets) to the increased importance and wide-spread use of donkeys, presumably over longer distances, and perhaps reflecting an increased importance in exchange of commodities.

## 6.2 Early Bronze I animal economy

### 6.2.1 Review of the research question

The Early Bronze IA was a period of recovery from the Chalcolithic collapse. It is characterized by small, unfortified, unplanned settlements, cruder, less specialized pottery and a shift in settlement pattern from the preceding Chalcolithic. The Early Bronze IB sees a population agglomeration, an increase in settlement size, a return to some specialized pottery production, and an increase in Egyptian and Egyptian-style artifacts in southern Levantine sites. Joffe (1993) sees the EB IA as relatively isolated with a low level of regional interaction, and the EB IB as involved in increasing interaction and exchange. These two distinct phases of the Early Bronze I are rarely distinguished in zooarchaeological studies. It is of great interest to ask what, if any, differences can be detected in the animal economy of these two periods.

Increasing social complexity and population agglomeration in the EB IB will see increasing specialization in various aspects of the economy. As the population at the settlement becomes denser and committed to long-term settlement, its demand for increased production can lead to specialization (Lewis 1996). As people devise more efficient ways of producing what they need, they become more skilled and committed to their craft, and gradually become interdependent and specialized.

Increasing social complexity in the EB IB might see the emergence of specialization in various areas of animal husbandry. In particular, the emergence of specialized herders would fit with denser population at a settlement. As the population becomes denser, it becomes less efficient to have herding activities taking place around the site (for example, herding near the site would compete for land needed for agricultural activities to support the population). The herding component of society would become farther and farther removed from the settled component, and likewise more interdependent. The type of specialized pastoralism (see Khazanov 1984; Grigson 1995) and the degree to which the pastoral component of society was removed from the settled component is difficult to determine. Shifts in kill-off strategies focusing on particular ages or sexes might provide evidence for changing herding practices in the EB IB. Changes over time in the sheep/goat ratio and in the degree to which various species were exploited might also indicate a focus on specialized herding in the EB IB.

Specialization in other areas of the economy might reflect changes in the animal economy. For example, increased agricultural activity to support a larger population in one area would add incentive to the use of draught cattle. The presence or absence of pigs at sites might also provide insight into the degree of sedentism and the intensity of agricultural or horticultural activities taking place at a site. No one of these lines of evidence can be used alone to indicate specialization in the animal economy.

### 6.2.2 Animal economy in the EB I (the Halif Terrace)

#### 6.2.2.1 EB IA at the Halif Terrace

An overview of the EB IA at the Halif Terrace has already been presented in section 6.1.2.3. To summarize briefly, the richest spectrum of taxa at the Halif Terrace occurs in the EB IA (Table 1). Sheep/goat numbers are lowest, and equid and pig numbers are highest in this period (Table 13). The EB IA also has the highest proportion of hunted animals, in particular gazelles. The sheep/goat kill-off indicates a strategy focused on meat. However, an absence of stage "D" mandibles noted in this period and in the late EB IB suggests some continuity in husbandry strategies between the two phases.

#### 6.2.2.2 Early EB IB at the Halif Terrace

The early EB IB animal bone assemblage comprises only 191 identified bones. However, the proportions are fairly consistent with the other periods from the Halif Terrace. A slight increase in sheep/goat (from 60.9% to 68.6%) occurs in the early EB IB. There is also an increase in cattle (from 9.9% to 14.1%) into the early EB IB. These increases correspond with a decrease in equids (from 13.2% to 8.4%), pigs (from 2.8% to 1%), and dogs (from 4.6% to 1%)[57] in the early EB IB. Additionally, the proportion of wild animals decreases, as does the taxonomic richness.

Sheep/goat kill-off during the early EB IB at the Halif Terrace is based on only 9 specimens. However, it indicates a predominance of juveniles, killed before 1-2 years of age. The epiphyseal fusion data support this kill-off, with 100% survival beyond 13-16 months, but only 60% survival beyond 1.5-2.25 years, and 0%

[57] The higher number of dogs in the EB IA may be related to the four dog skeletons found in one area. While each of the skeletons have been counted as "1" in the relative frequencies table (Table 13), it is possible that some bones were not recognized as belonging to one of these burials, and so inflate the relative frequency of dog.

survival beyond 2.5 years. For the herd to persist, breeding age animals are needed, indicating that this is a far too small sample size from which to draw any conclusions.

6.2.2.3 Late EB IB at the Halif Terrace

The late EB IB from the Halif Terrace comprises the largest of the three assemblages from this site (1117 identified specimens). The late EB IB sees the highest proportion of sheep/goat of all three periods at the Halif Terrace. It also comprises the lowest proportion of equids (6.1%) and a lower proportion of pigs than in the EB IA. The decrease in the presence of pig from the EB IA to the late EB IB may reflect certain social factors, such as intensification of agriculture or culinary preferences of the different populations living at the site[58]. From her work at Tell Halif, Zeder (1990:28) concludes that:

> "in Palestine, pigs appear to play a more important role during times of weaker political integration and relaxation of central control, and become less commonly utilized in periods when there is greater evidence of integration within a regional urban economy".

As discussed above, pigs produce no secondary products and were found in ancient Egypt to have been used as a supplementary meat item on a household basis (Redding 1991). When maintained in areas that raise field crops (grain), pigs compete with humans for food resources (Redding 1991). The infrequency of pigs bones in the late EB IB at the Halif Terrace, together with the decrease into the late EB IB, may indicate that an increase in agriculture occurred in this period, but that some pigs were still maintained as a convenient source of meat, probably on a household basis.

While some of the larger cattle bones from the Halif Terrace have been identified as coming from wild cattle, I argue that they might instead represent heavier individuals of domestic cattle. If these bones were from wild cattle we would

[58] The majority of the animal bones from the areas with Egyptian style pottery (from the 1995 and 1996 excavations) are not yet studied. Future comparisons between the "Egyptian" and "Southern Levantine" areas might identify some differences in the use of pigs which parallel the different populations living at the site.

find a variety of elements falling within the range for wild cattle[59]. However, at the Halif Terrace, the four largest bones (relative to the wild standard) are metacarpals and phalanges. With heavy pulling associated with draught, the forelimbs bear the most weight, sometimes resulting in broadened distal metacarpals and phalanges[60]. The presence of these labor-related elements and no others in the wild size range suggests that they may come from a small number of stocky individuals who might have been used for draught at the Halif Terrace.

The location of the Halif Terrace on the northern Negev/southern Shephelah/coastal plain interface deems this to be what Redding considers a "good" environment (Redding 1984). The sheep/goat ratio during the late EB IB is 2.3:1, based on 104 sheep and 45 goats. This ratio suggests that herding activities were focused on herd maintenance and that more emphasis was placed on sheep than on goat. The possibility of wool exploitation is supported by the sheep/goat survivorship which indicates a higher maintenance of adults than seen at Shiqmim or at Afridar.

Sheep/goat mandibular tooth eruption and wear and epiphyseal fusion from the Halif Terrace indicate that animals were kept to older ages, typically up to three years of age, with a slow decline after three years. This suggests that the people of the Halif Terrace during the late EB IB used a mixed strategy of meat, milk, and wool production.

The total absence of sheep/goat killed-off at the age of 1-2 years in the late EB IB at the Halif Terrace is outstanding. The absence of mandibles of this age implies that *no* individuals were killed in the 1-2 year age range. As this is nearing the time of prime kill-off and age of maximum growth (ca. 3 years), it seems unlikely that none of the herd was killed at this age. It is quite possible that when individuals reached this age range a decision was made: they were either kept to older ages for

[59] This presumption depends on the method of hunting and butchery. It is possible that the wild aurochs carcass was butchered in the field, and brought back to the settlement in a "bag" of its own hide, with the lower extremities still attached. This would account for the presence of only foot bones in the assemblage.

breeding, milking, and wool, or they were taken somewhere else to be killed for meat. Zeder sees a tight focus of exploitation of animals six months to two years of age as indicating direct meat provisioning by herders (Zeder 1991:147). The data from the Halif Terrace provide evidence for another aspect of meat-production which was not expected in this study—that is, the potential for this kill-off pattern to indicate some kind of involvement of the EB IB Halif Terrace population in a market or redistribution system (seeing that the entire population of animals in that age range is missing from the death assemblage). The missing age category and the indications of increased wool exploitation in the EB IB will become relevant again in the next section regarding the EB IB southern Levantine relationship with Egypt.

### 6.2.3 Changes in the animal economy from EB IA through late EB IB

The late EB IB at the Halif Terrace provides the first evidence in this study that resembles Horwitz and Tchernov's (1989) characterization of the Early Bronze Age. The sheep/goat mortality curve from the late EB IB reveals that secondary products were being exploited more intensively than in the EB IA. While not on the same scale as the Chalcolithic, milk exploitation certainly was a component of this system. The same applies to Horwitz and Tchernov's claim that 80% of sheep/goat in the Early Bronze Age survived to adulthood. For the first time in this study, in the Late EB IB at the Halif Terrace, we see nearly 80% of the sheep/goat surviving into adulthood (2-3 years) as Horwitz and Tchernov claimed. The sheep to goat ratio of 2.3:1 in the late EB IB at the Halif Terrace is the highest ratio in the Halif Terrace sequence (see Table 30). This increased use of sheep over goat also agrees with an increase in sheep observed by Horwitz and Tchernov's for the Early Bronze Age as a whole.

The social changes proposed for the EB IA through the EB IB include increasing social complexity and population agglomeration in the EB IB. This study

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[60] Of these four specimens, only one (a proximal first phalanx) is noted for signs of pathological broadening, perhaps related to strain from draught.

predicted that, along with specialization in other aspects of the economy, we would see increased specialization in certain areas of animal husbandry. Specifically with regard to population agglomeration into denser settlements, we might expect to see the removal of herding activities away from the site. This implies a portion of the population specializing in herding. This study predicted that specialized herding would be reflected in the emergence of more specialized herding strategies, focusing on particular ages or sexes depending on the motivations of the herders. It also proposed that denser populations would require specialization in other areas, such as agriculture, in which case we would see an increase in the use of draught cattle.

The Halif Terrace faunal assemblages provide useful for studying the degree of change from the EB IA through the late EB IB. In general, the picture fits with the social changes described above and in Chapter 2. The EB IA at the Halif Terrace has the highest taxonomic richness, the highest proportion of equids, pigs, and hunted wild animals. The sheep/goat population reflects a strategy of generalized meat production and no particular focus on one product (meat, milk, or wool). In general, the picture is of a settlement with no indications of central control or specialization within the animal economy. The diversity of taxa might indicate short-term (or seasonal?) occupation where the population had not yet over-exploited the local environment. A higher number of pigs in the EB IA might indicate household production and less intense involvement in agriculture than in the later periods. The higher proportion of equids during the EB IA than in later periods is outstanding. As discussed above, they might indicate increased exchange and/or mobility in the EB IA, which not only served as a risk reduction strategy, but also as a catalyst in the increasing interaction with Egypt during this time.

Data from the EB IB at the Halif Terrace point to increased specialization in the animal economy that fits with the picture of population agglomeration and increasing social complexity throughout the EB I. An increase in the relative proportions of sheep/goat compared to other exploited taxa from the EB IA through the late EB IB points to an increasing reliance or focus on sheep/goat. Additionally, a maintenance of the majority of sheep/goat to adulthood in the late EB IB suggests a certain degree of secondary products exploitation, perhaps involving wool production. The sheep/goat ratio increases over time, from 1.8:1 in the EB IA to 2.3:1 in the late EB IB. This indicates a growing preference for sheep at the Halif Terrace, possibly due to increased focus on wool exploitation.

Further evidence for specialized herding strategies is found in the absence of "D" stage mandibles (representing sheep/goat killed at 1-2 years of age). In the Period IVB town at Kurban Höyük, Wattenmaker interpreted the absence of sheep/goat slaughtered between 2-3 years as evidence for their export to another area of the settlement or another settlement (Wattenmaker 1987). It is likely that the inhabitants of the Halif Terrace selected a portion of their 1-2 year old sheep/goat to be sent away, maintaining a few for the propagation of the herd. As mentioned before, if provisioning involves meat, the consuming site would have a high number of prime meat animals, while the provisioning area would have a complimentary kill-off representing the other ages (Stein 1987). The data from the Halif Terrace therefore fit wit a picture of the site as a provisioning area, where the spectrum of ages is represented, but one specific age group is missing. These clues regarding sheep/goat herd management and secondary products exploitation all point to an increasing specialization in sheep/goat management in the late EB IB, with a focus on wool production.

Specialization in the realm of sheep/goat management may have been paralleled by specialization in other aspects of animal management in the late EB IB at the Halif Terrace. The second most predominant species at the Halif Terrace is cattle. In light of increasing population density and more intensive agricultural production, we may expect to see an increase in the use of draught animals. As discussed above, some of the bones identified as coming from wild cattle at the Halif Terrace, I choose to interpret as coming from heavier forms of domestic cattle, possibly draught cattle. Unfortunately, while some draught cattle may make up a portion of the assemblage, there is little else with which to support the use of draught cattle, and certainly not on any intensive scale. The small sample size of cattle bones at the Halif Terrace (n=185) might very well explain the dearth of pathological cattle bone in the assemblage. Only two bones from the Halif Terrace show signs of pathology that can be related to the use of cattle for draught. The absence of intensively exploited individuals is not surprising in light of the steep kill-off of juvenile cattle in the late EB IB, where less than 20% survive beyond 3.5-4 years (the oldest age category).

Results from the Halif Terrace indicate notable changes from the EB IA through the late EB IB. In particular, the late EB IB sees a certain degree of specialization with regard sheep/goat exploitation. An increased focus on sheep/goat, a preference for sheep, and a maintenance of sheep/goat to older ages all provide evidence for a focus on pastoralism and the exploitation of wool during the EB IB. If agriculture was intensified during the EB IB in response to increased social stratification and/or population density, there is little evidence for draught cattle being exploited intensively for agricultural purposes. However, a decrease in pigs in the late EB IB might indicate an intensification in agricultural activity or less production of meat on a household basis. The absent "D" category in sheep/goat kill-off points to the removal of 1-2 year old sheep/goat, perhaps as part of a market or exchange network (or even tribute).

## 6.3 Early Bronze I interaction with Egypt

### 6.3.1 Review of the research question

Sporadic contact between Egypt and the southern Levant during the Chalcolithic increased during the EB IA and climaxed in the EB IB, during which time it is thought Egyptians were living in southern Palestine. Imported Egyptian and locally made Egyptian-style ceramics and chipped stone tools point to a close relationship between the two areas. It is generally thought that the relationship had some commercial component, involving trade or export of goods such as wine, olive oil, tree resin, copper, and dead sea minerals. If this intensified contact took place on an overland route, zooarchaeological evidence would find an increased use of donkeys for transport in the EB IB. If these commercial relations involved animals or animal products for export, we would see animal management focusing on certain ages, sexes, or species. On the other hand, if the relationship was one involving hierarchical military or colonial occupation, we would see some indication of provisioning or tribute, and distinct boundaries between Egyptians and southern Levantine locals.

### 6.3.2 The role of donkeys in EB I contact

The role of the domestic donkey in facilitating mobility, contact, and exchange is the key zooarchaeological line of evidence for understanding the relationship with Egypt during the Early Bronze I. The potential for long-distance transport of people and goods has far-reaching effects on economy and foreign relations. The importance of equids in facilitating these relations might have led to a special perception of domestic donkeys in the early stages of their spread across the Near East. Several examples of ceramic figurines of donkeys carrying loads from Early Bronze I sites[61] (Epstein 1985; Ovadia 1992) emphasize the value of equids for transport during the Early Bronze Age.

Equid bones, like those of dogs, are often found articulating and in differential preservation than those of the primary meat animals (sheep/goat, cattle, and pig). Caution must be taken when quantifying and interpreting equid bones. High numbers of equid bones in the assemblages from Afridar Areas E and F do not seem to be a factor of poor preservation or biased selection. There is some indication that the small toe bones of sheep/goat and pigs were occasionally overlooked at Afridar Areas E and F; however, a high occurrence of fish bones in the Afridar Area E assemblage indicates both careful excavation and good preservation.

[61] One donkey figurine from a Chalcolithic ossuary cave at Giv'atayim may be intrusive from overlying EB I remains (Ovadia 1992).

Before speculating on the role of equids at Chalcolithic and Early Bronze Age sites, it is important to clarify just *which* species of equid we are talking about. Equid remains are found, usually in small numbers, in many sites dating to the Chalcolithic and Early Bronze periods, and there is always a question as to their taxonomic status: whether they are of horse (*Equus caballus*), onager (*Equus hemionus*), wild ass (*Equus africanus*), or domestic donkey (*Equus asinus*). It is thought that the domestic donkey became quickly widespread as an animal for transport all over the Near East and Egypt during the Early Bronze Age (Grigson 1993). However, given the early date of Afridar, it is possible that the equid bones found here are wild onager, ass, or even domestic horse. The presence of horses has been noted at both Chalcolithic (Grigson 1993) and Early Bronze Age sites (Davis 1976).

Log ratio plots of equid measurements from all three sites reveal that a handful of the bones come from horse-sized equids. Horse bones from the Chalcolithic have been proposed to come from domestic individuals, based on the likelihood that wild horses were not present in this area in the 4$^{th}$ millennium BCE (Grigson 1993). However, recent studies suggest that the natural range of the wild horse might have extended farther than was previously thought (Levine 1999). The sites in which horse bones have been found during the Chalcolithic and Early Bronze I (Arad, Grar, Halif Terrace, Afridar, Shiqmim) are all located in relatively dry environments, the type of steppic environment inhabited by wild horses. Horse bones have not yet been found in these periods in the hill country, and presumably will not be found in hilly areas until they are taken there after domestication. The horse bones from Shiqmim, Afridar, and the Halif Terrace, therefore, might indeed be a part of the wild assemblage rather than the domestic.

Having distinguished the few horses among the equids from Afridar and the Halif Terrace, we are left with asinine equids. These remaining specimens could be wild ass, onager, or domestic donkey. The bones and teeth of these species are difficult to distinguish, although the long bones of the onager are thought to be slightly longer and thinner than those of the ass (Davis 1980a). As metrical and morphological determinations between wild ass, onager and domestic donkey are rather inconclusive in this case, perhaps the most helpful information will come from looking at the demographics of the equid populations at Afridar and the Halif Terrace. The high percentage of equid remains is rather convincing evidence, for a number of reasons, that the bones are of the domestic donkey (*Equus asinus*). First, there appears to have been a slight increase in the number of equid remains at sites from the Chalcolithic to the Early Bronze Age (Ovadia 1992), most likely corresponding to the introduction of the domestic donkey to the area. In addition, it appears that wild animals played a minor role in Chalcolithic and Early Bronze Age economies in general in the southern Levant. Sites of this period typically produce a few remains of gazelle, deer, and hartebeest, but in very small numbers.

The predominance of adult equids as well as the differential disposal and low fragmentation of equid bones at both sites points to their use primarily for labor and mobility, and perhaps secondarily for food and skins. A small number of cut marks indicate that humans were doing something to the equid carcasses after their death. The location of the cut marks on the lower parts of the limb (with the exception of a cut mark on one proximal femur from Afridar) suggests that the cuts are the consequence of skinning.

Further evidence that equids were not regularly eaten by humans is found in the dog burial from Afridar Area E (described in section 5.3.4). The dog was buried with its head lying on a nearly complete equid tibia that showed signs of having been gnawed. Textual evidence from the Ur III Mesopotamian center of Drehem reports that asses were given "to the dogs" (Zeder 1994). This appears to hold true, at least according to evidence from this singular event. If donkey meat was not eaten regularly by humans, it would make sense to give it to the dogs. In sum, the role played by equids at Afridar and the Halif Terrace seems to have been primarily that of labor and transport, rather than food.

The Early Bronze age is the period in which the domestic donkey became a wide-spread beast of burden across the Near East (Ovadia 1992). The high numbers of equids during the EB IA at Afridar and the Halif Terrace would have been an important factor in the economy, possibly for the movement of copper and other materials from faraway areas that were previously more difficult to access (such as the Wadi Feinan area in Jordan) (Levy 1995), or to faraway areas (such as Egypt). The abundance of equid remains from Afridar Area E, together with over 90 pits and evidence for copper working, suggests that the inhabitants of the site may have taken part in some kind of industry requiring large amounts of raw materials, and possibly involved in a larger transportation or trade network. In light of the increasing contacts with Egypt during the Early Bronze Age, the significance of the donkey in the facilitation of overland routes of contact is brought to the forefront (Gophna 1995:278-279). The location of Afridar on the coast might also point to a link between overland transport of goods by donkeys to the coast where some degree of maritime transportation may have been underway.

### 6.3.3 The relationship with Egypt in the Late EB IB

The general impression of the relationship between southern Palestine and Egypt during the EB IB is one of commercial contact. Possible areas where commercial contact might manifest itself zooarchaeologically are an increased use of donkeys in the EB IB as well as an intensification of potential products for export, such as wool or particular animal species or age groups.

Donkeys are not present at Shiqmim, a fact which right away limits the amount of international contact with Egypt. Contact between Egypt and the southern Levant is attested for during the Chalcolithic in both Egyptian ceramics appearing in the southern Levant and southern Levantine ceramics appearing in Egypt, as well as shared motifs and technologies (in ceramic styles and flints) (Rizkana and Seeher 1989). Without the donkey, this contact would have been slower with less movement between the two regions than in subsequent periods where the donkey facilitated movement.

Contrasting with Chalcolithic Shiqmim, the donkey appears in high numbers in the animal bone assemblages from EB IA Afridar and the Halif Terrace. This is a period during which contact with Egypt appears to have heightened from the preceding Chalcolithic, and evidence for an Egyptian presence is found at some sites on the southern Levantine coast (En Besor Site H and Taur Ikhbeineh) (Gophna 1992; Oren and Yekutieli 1992). The domestication and spread of the donkey had an undoubted influence on the heightened and changing nature of contact between these two areas, and between the various regions of the southern Levant as well.

While donkeys are present in relatively high numbers in the Late EB IB at the Halif Terrace (compared with other Early Bronze Age sites, see Table 2), their relative proportion is much lower than it had been during the EB IA. In fact, donkeys were twice as prevalent during the EB IA than during the late EB IB at the Halif Terrace. During this period (EB IB) Egyptian contact is thought to have been greatest. A decrease in donkeys suggests a decrease in trade and mobility. While it is not evidence *against* the Egyptian presence in the southern Levant in the late EB IB being one of commercial contact, it suggests that the contact was less intensive during the EB IB than in earlier periods when the numbers of donkeys are higher. These results must be interpreted with caution because they are likely specific to the Halif Terrace and perhaps cannot serve as a model for the region. This is a site at which it is proposed Egyptians and local Canaanites lived side by side. The animal bone assemblage might therefore reflect local rather than commercial activities. The site may have produced goods for export to Egypt; however, the donkeys used in transport may only have passed through the site, so we would not find their remains. However, this does not explain the higher numbers of donkeys during the EB IA . Further evidence is needed other than the relative numbers of donkeys in each period.

As discussed above, the absence of "D" stage sheep/goat mandibles may reflect the removal of a portion of the 1-2 year olds from the flock annually. If the

Halif Terrace is the provisioning site (or area), where is the consuming site (or area)? A commercial relationship with Egypt might point to an answer. If sheep/goat were a component of the Egyptian resource interests as Ben-Tor (1991) proposed, then the 1-2 year olds may have been taken elsewhere (to Egypt?), apparently on the hoof. A preference for sheep and a maintenance of the majority of flocks to maturity in the late EB IB at the Halif Terrace suggests that wool was an element of the late EB IB animal economy. Since early Egyptian sheep did not produce wool (Bökönyi 1985), wool may very well have also been an element of late EB IB commercial relations between Egypt and the southern Levant.

An increased focus on sheep and older animals during the late EB IB at the Halif Terrace might indicate specialization in wool production, perhaps to meet an Egyptian demand for wool products. While we cannot determine the extent of this specialization, it is interesting to speculate on what the nature of the specialists may have been. The nature of sheep/goat husbandry alone suggests independent specialists who can be separated from the site for periods of time, carrying out their activities rather autonomously. Sheep/goat products such as wool fall into the "utilitarian" category, which is more often associated with independent specialists (while "prestige" objects are produced by attached specialists). It is also likely that specialized herders provisioned numerous communities in the area, which suggests some independence in their specialization. There is no evidence for a central institution where attached specialists could be supervised, animals could be penned, and production and distribution could be monitored[62]. However, it is possible that the processing of wool into products such as textiles may have been undertaken by attached specialists in an as yet undetected central institution, or could have been the work of noncentralized attached or independent specialists weaving in a workshop or home.

In sum, while the evidence indicates that there is a missing age group, indicating some regular and long-term husbandry strategy, and that wool production was an element of late EB IB sheep/goat exploitation, it is just as likely that these products were exchanged in a local or regional network as it is that they were exported to Egypt. Without evidence from Egypt for the import of these proposed products (young sheep/goat and wool), the results remain tentative.

In the case that the southern Levant was occupied by military or colonists, I predicted in this hierarchical system to find evidence for tribute or provisioning. Zooarchaeological evidence for colonization are taken from the EB IB at the Halif Terrace. This is the only site in this study that can provide evidence regarding colonization because it is the only one where Egyptians are thought to have lived. Here the equifinality of the results again presents itself. The absence of stage "D" mandibles discussed above can be interpreted as evidence for provisioning. However, Egyptians and southern Levantine peoples are proposed to have both been living at the Halif Terrace. If provisioning were occurring at the same site, we would find the missing 1-2 year olds somewhere in the assemblage from the Halif Terrace[63]. Another area where we might find evidence for a colonial presence is in tribute. This might be found zooarchaeologically in evidence for rare, wild, or prime age animals appearing in Egyptian areas of the site. Other than one horse and a few wild cattle, which are found also in other phases of the Halif Terrace, no other evidence for tribute has yet been found among the animal bones. A small-scale spatial analysis indicates that there is an even representation of species and body parts across the site, so we cannot determine if Egyptians were consuming particular cuts or species.

With no evidence for an "Egyptian" area, colonialism is difficult to substantiate at the Halif Terrace. Likewise, the results of faunal analysis provide no evidence that can be interpreted as resulting from a colonial presence where Egyptians remained relatively separated from the local Canaanites. While this does not suggest that the Egyptian presence in the southern Levant did not involve

[62] The few seal impressions recovered at the Halif Terrace (Levy et al 1997) are not sufficient evidence for the existence of a bureaucracy that monitored large-scale production and distribution.
[63] That is unless, of course, the area in which they are to be found has not yet been analyzed.

colonialism, evidence from the EB IB at the Halif Terrace points to a relationship of a different nature.

Both archaeological and zooarchaeological evidence from the EB IB at the Halif Terrace points to non-colonial, peaceful coexistence. Results of the spatial analysis described above indicate an absence of differentiation, or unclear boundaries between areas. However, the area included in this study is small. Additionally, a lack of differentiation between animal bone refuse might be the norm: where we see distinctions in ceramic distribution, we might not see distinctions in organic refuse simply due to discard habits. This method clearly deserves further attention. Upon complete identification of the total animal bones from all areas of the Halif terrace (to be completed by the author in 1999), spatial analysis may provide some interesting insight into ethnicity and use of space during the Late EB IB at the Halif Terrace. Indeed, Kansa (1998) has noted some differences (marked, however, by very unclear boundaries) in pottery distribution across the site of the Halif Terrace, especially between the "southern Palestinian" areas and the "Egyptian" areas during the late EB IB. These differences in ceramics suggest that we might expect to find evidence for differential preparation and discard within the site's bone assemblage as well.

Until further analysis can be undertaken, the present faunal data provide little evidence for hierarchical military occupation or forceful colonization as characterizing the EB IB relationship between Egypt and the southern Levant. Zooarchaeological data provide more support for commercial relations as characterizing this relationship. These relations likely commenced during the Chalcolithic in the form of sporadic contact between the two regions. In the EB IA this relationship intensified with the use of the domestic donkey. The donkey facilitated the transport of goods and people on a local, regional, and international level. The donkey is the key factor in the development and facilitation of the Egyptian-southern Levantine relationship during the Early Bronze I. While we still do not know what animal products (if any) took part in exchange with Egypt, it seems like that wool (along with the sheep?) or wool products were one component of that exchange.

# Chapter 7

# Conclusions

## 7.1 Summary of findings

This thesis has approached the Chalcolithic-Early Bronze I transition in the southern Levant through analysis of changes in the animal economy at three sites in southern Israel. Results of zooarchaeological analysis point to variations in exploitation strategies and specialization within in animal economy from the Chalcolithic through the EB IB. These results further imply that the Chalcolithic through the EB IB did not see a steady increase in social complexity towards the first "urban" areas in the EB II. Rather, specialization within the animal economy fluctuated according to the changing social and political environment.

The Chalcolithic represents a stable, flourishing period with permanent villages and a highly defined political and social organization. Animal exploitation in the Chalcolithic at Shiqmim focused on intensive sheep/goat exploitation for milk, which may have been a component of a regional system of small-scale exchange and risk-reduction. After nearly 1000 of remarkable cultural uniformity on an inter-regional basis, the Chalcolithic came to an end around 3700-3500 BCE. This study used zooarchaeological evidence to test some of the possible factors that have been proposed to have contributed to the end of the Chalcolithic. While the collapse likely involved a combination of factors, among which was probably some kind of climatic fluctuation, zooarchaeological evidence supports the theory of commercial relations with Egypt as contributing to the collapse. The domestication and wide-spread use of the donkey was a key factor in the increased contact between Egypt and the southern Levant at the beginning of the Early Bronze I. Artistic representations from the Early Bronze Age point to the ideological importance of the donkey, and the sheer potential that the donkey provides for contact and exchange of goods and ideas is enough to have instigated change in Chalcolithic society with its symbol-heavy system of tribute and gift-giving.

The subsequent Early Bronze IA is a period of recovery from the Chalcolithic collapse, but in which there are threads of continuity, sometimes quite significant. The EB IA sees smaller, more ephemeral settlements with a less clearly defined political organization than in the preceding period. The more specialized herd management system seen in the Chalcolithic gave way in the EB IA to a mixed, diverse economy aimed at risk management with few signs of specialized animal production, indicating a period of instability. The large numbers of donkey bones at Afridar suggest movement, perhaps of goods and people on a wide scale. Increased movement fits with the picture of increasing contact with Egypt in this period that climaxed during the EB IB.

The socio-political organization during the EB IB sees a return to more permanent settlements and a population agglomeration that eventually gave way to the first walled settlements in the EB II. The animal economy of the EB IB once again sees a return to more specialized activities, this time aimed at the production of commodities for exchange. A focus on sheep/goat and a decrease in other taxa indicate the importance of the pastoral component of society in supporting the increasing population density proposed in the EB IB. An absence of 1-2 year olds in the Halif Terrace assemblage might point to involvement in some kind of regional exchange or provisioning network. Kill-off patterns indicating the maintenance of sheep/goat to older ages provides the first evidence for intensification in wool production during the EB IB. Wool and wool products might have played a role in the relationship between the southern Levant and Egypt during this time. Relations between the southern Levant and Egypt, which commenced during the Chalcolithic in the form of sporadic contact between the two regions, intensified in the EB I with the help of the recently domesticated donkey. The donkey played a key role not only in facilitating long-distance contact and exchange: considering its recent domestication in the Early Bronze I, the donkey may have played an even more important role in *instigating* it.

## 7.2 Directions for future research

Zooarchaeological analyses of southern Levantine materials rarely involve inter- or intra-regional comparisons. Additionally, few studies compare the Chalcolithic with the Early Bronze Age, or the various distinct phases of the Early Bronze Age. In fact, the majority of zooarchaeological analyses from both the Chalcolithic and the Early Bronze Age of the southern Levant are individual reports. These are sometimes in the form of a chapter or an appendix in a comprehensive volume from an excavation. More often, however, a zooarchaeological study appears as a short section within the text of another article or as an article in a journal, often entirely disassociated with its original (and highly relevant) archaeological context.

This study has shown that significant contributions to interpreting the past can be made using zooarchaeological analysis. The value of zooarchaeological analysis is even greater when the data can be placed in the broader picture involving social, political, and economic activities. This study, therefore, stresses the importance and *necessity* of incorporating zooarchaeological analysis into the broader archaeological picture, and calls for future research to appreciate the contributions and inter-relationships of the many archaeological sub-disciplines.

Animal bone analyses are "a potentially important means of corroborating activities identified with architectural and ceramic data, and of illuminating aspects of these activities not accessible through other means" (Potter 1997:362)[64]. Indeed, differences have already been detected in small-scale studies from the Chalcolithic and Early Bronze Age of the southern Levant. However a thorough and convincing spatial analysis requires corroboration with other aspects of the material culture, such as architecture, ceramics, and archaeobotanical analyses. Excavated areas often include only one or two households. Future research necessitates corroboration and

[64] Potter detected variations in the scope and intensity of ritual activities among roomblocks in Anasazi settlements in the American southwest.

clear contextual data to be incorporated into spatial analysis involving many households so that behavioral variations can be detected.

A small-scale spatial analysis was attempted at the Halif Terrace to detect differential activities among Egyptians and locals. The data to date do not provide a large enough sample with which to detect differences: all taxa and body parts were present in fairly even numbers in all analyzed areas. However, interpretation awaits completion of the laboratory analysis on the Halif Terrace bones. Future analysis will involve spatial analysis of animal bones from the entire excavated area. Given the dramatic differences already noted in the distribution of ceramics from the Halif Terrace, a future full-scale spatial analysis of animal bones will be extremely informative.

Results of this study continually point to the importance of equids not only in relations with Egypt in the Early Bronze I, but also as a potential factor in the collapse of the Chalcolithic, and the rise of the first "urban" areas in the southern Levant. This study has addressed certain issues relating to the early use of domestic donkeys. The abundant assemblage of equid bones at Afridar and the Halif Terrace will provide useful for future research regarding: the ancient distribution of wild equids and their exploitation in the southern Levant; the origins of donkey domestication and the means by which donkeys spread into this region; the first use of donkeys for labor and transport; and further investigation into the social and ideological significance of donkey use in these early stages. The early date of Afridar indicates that this might be one of the first sites to exploit domesticated donkeys to such an extent, making the data from Afridar very important to our understanding of the origins and spread of the domestic donkey. Future investigations into equid use during these periods should also involve research regarding the status of horse bones from Chalcolithic and Early Bronze Age sites. If the horse bones from Shiqmim and Afridar (and other sites in the southern Levant) are from wild horse, this provides new evidence for the ancient range of the wild horse.

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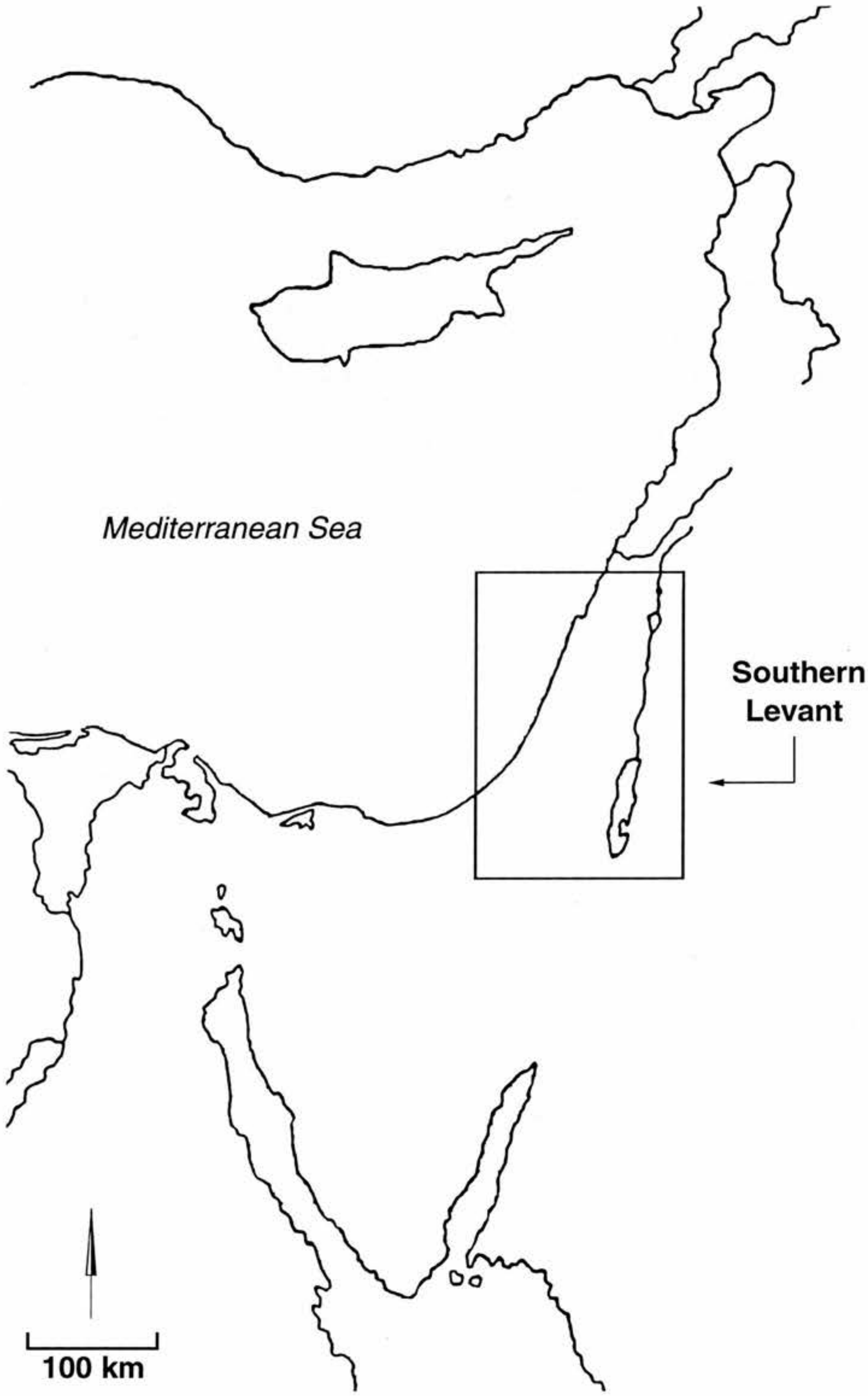



**Illustration 1:** Map of the Eastern Mediterranean, indicating the study area (the southern Levant) [Modified after Joffe (1993), Figure 11, p.42)]

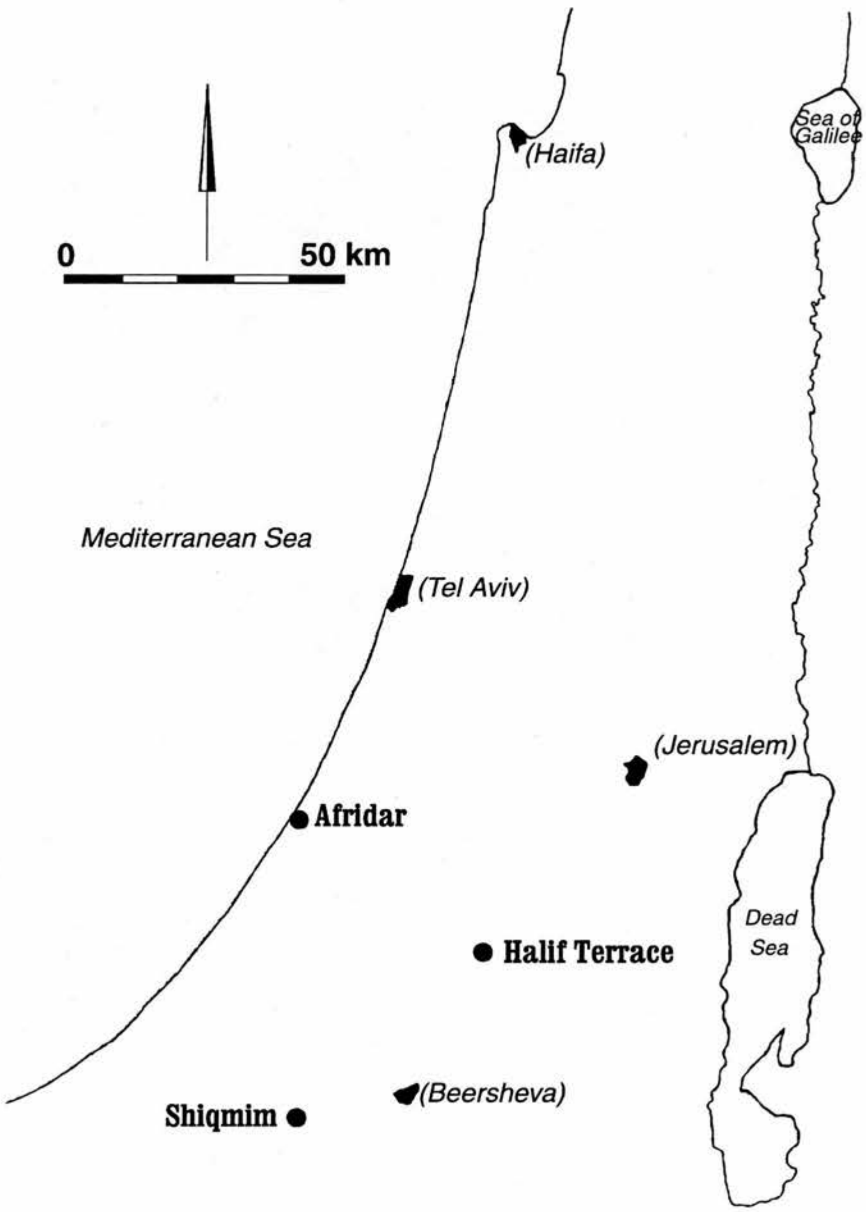



**Illustration 2:** Map of the southern Levant, indicating the location of the three sites under study. For reference, the locations of cities in modern Israel are noted in parentheses. [Modified after map of Israel in *Excavations and Surveys in Israel* **15** (1997), p. 103]

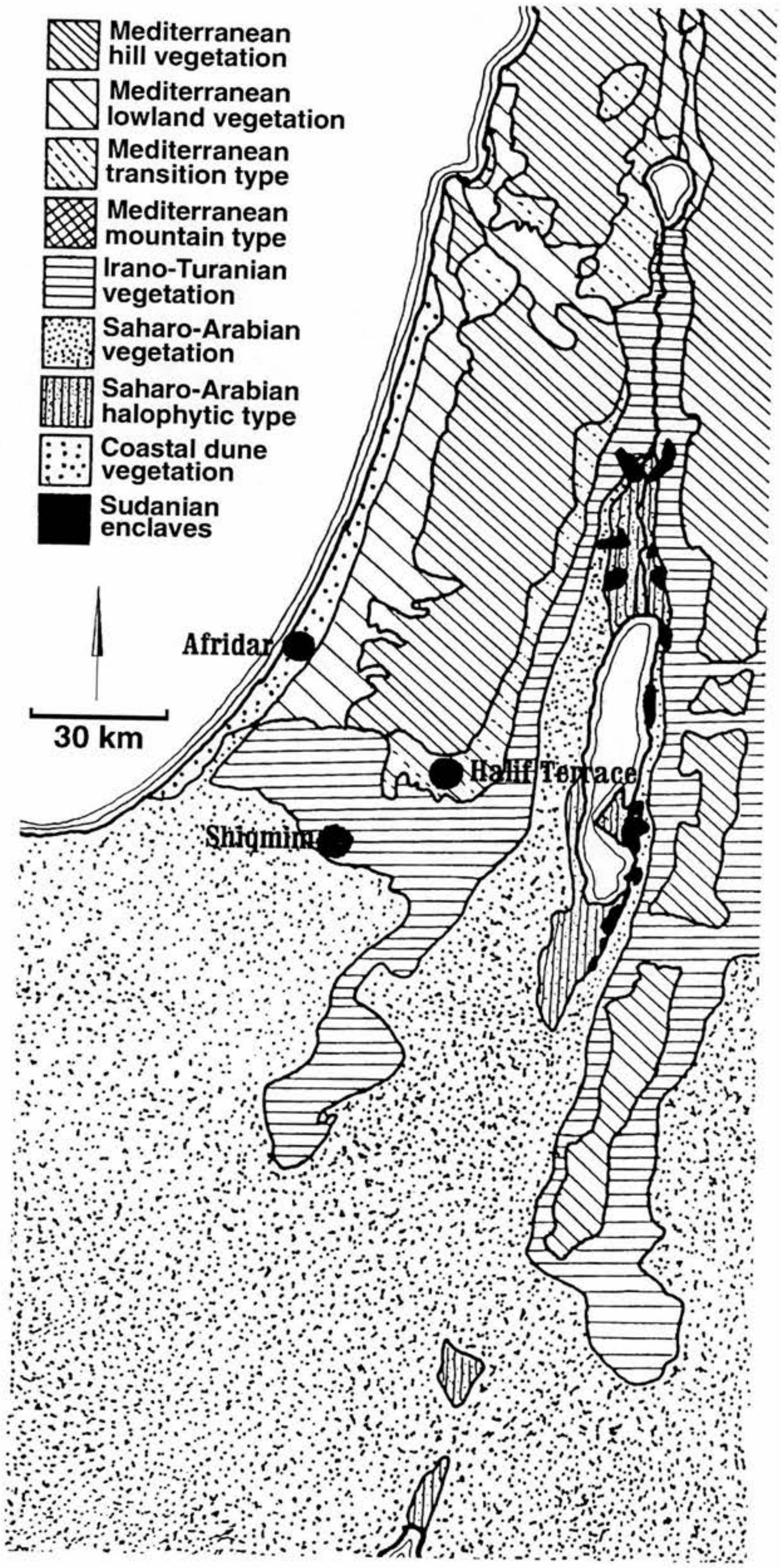



**Illustration 3:** The location of Shiqmim, Afridar, and the Halif Terrace in the context of the main phyto-geographic regions of the southern Levant [Modified after Joffe (1993) Fig. 4, p.26]

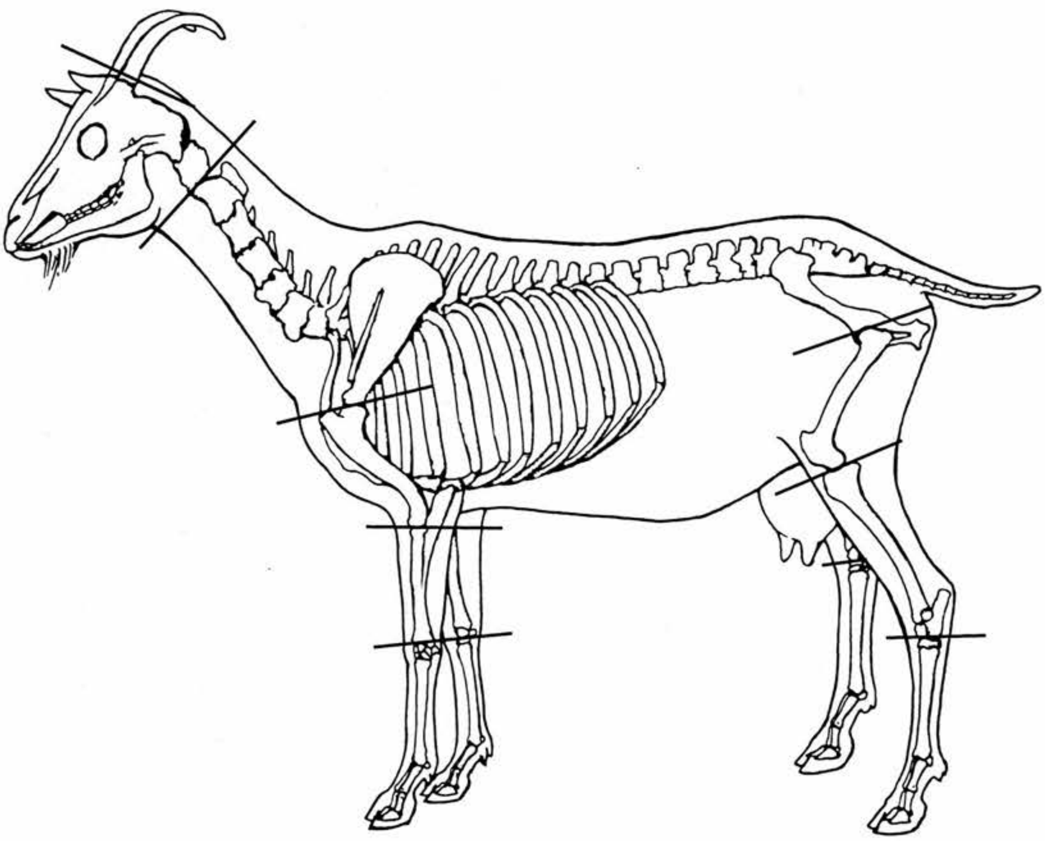
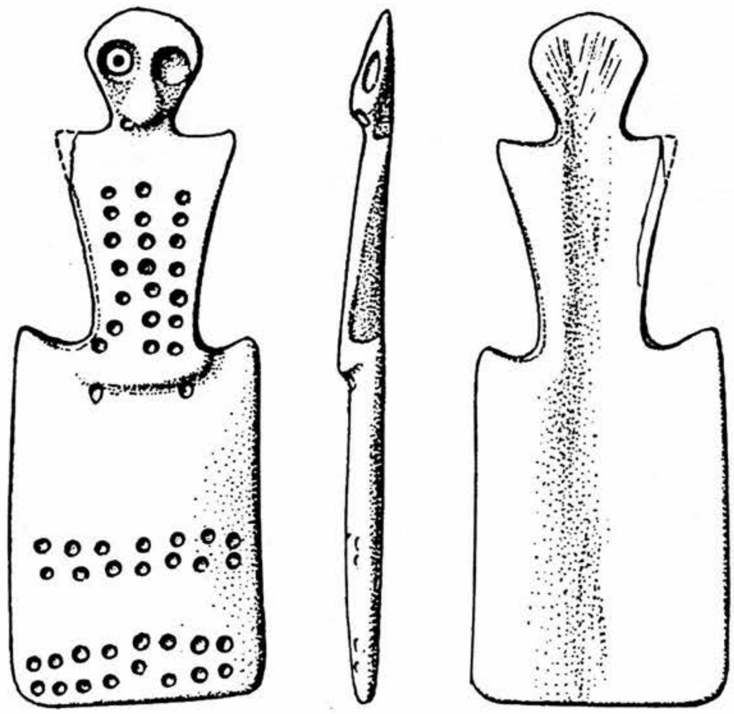


**Illustration 4:** Method of dismemberment of sheep/goat at Shiqmim, based on location and frequency of cut marks. [Modified after Barone (1976), p. 23, Plate 8]



**1:1**

**Illustration 5:** Anthropomorphic figurine made from a large mammal scapula. The figurine was found in a pit (Locus 4160) containing partially articulated bone remains of at least four individual sheep/goat. [After Levy and Golden (1996:151)]

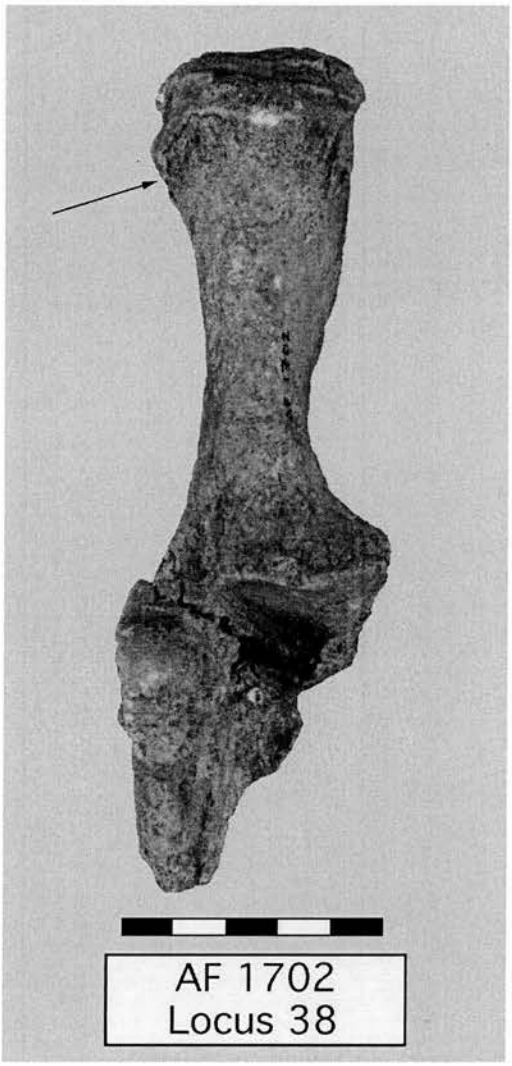



**Plate 1:** Wild cattle (*Bos primigenius*) calcaneus from Afridar (the arrow points to the fusion line, which is still visible, indicating a young individual)

**Plate 2:** Sheep/goat (*Ovis aries/Capra hircus*) teeth with swollen roots from Shiqmim

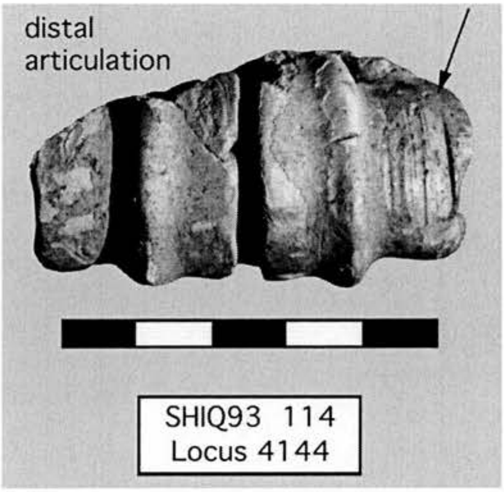



**Plate 3a:** Distal view of cattle (*Bos taurus*) metacarpal from Shiqmim (SHIQ93 114) with broadening and incisions from rubbing against phalanx 1. These types of skeletal disorders are often associated with intensive use of the animal for draught

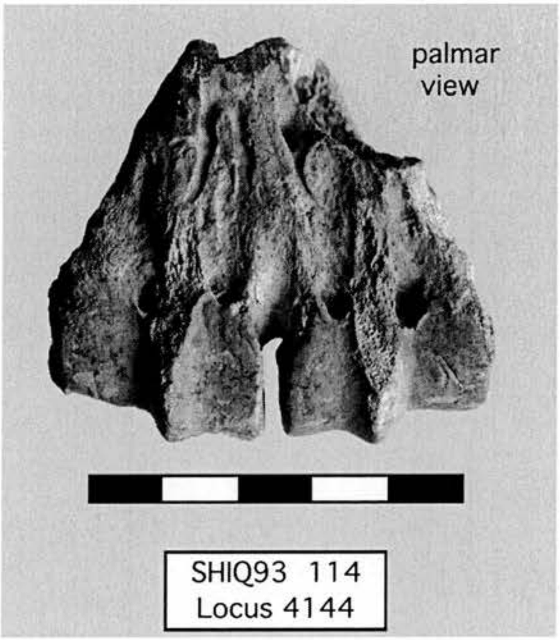



**Plate 3b:** Palmar view of cattle (*Bos taurus*) metacarpal from Shiqmim (SHIQ93 114) showing evidence of palmar depressions.

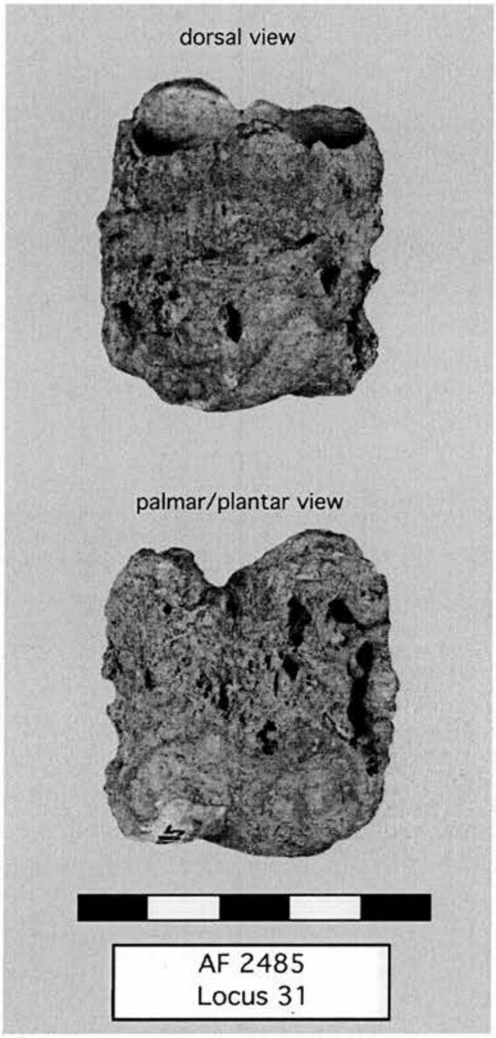



**Plate 4:** Cattle (*Bos taurus*) phalanx 2 with severe exostosis throughout

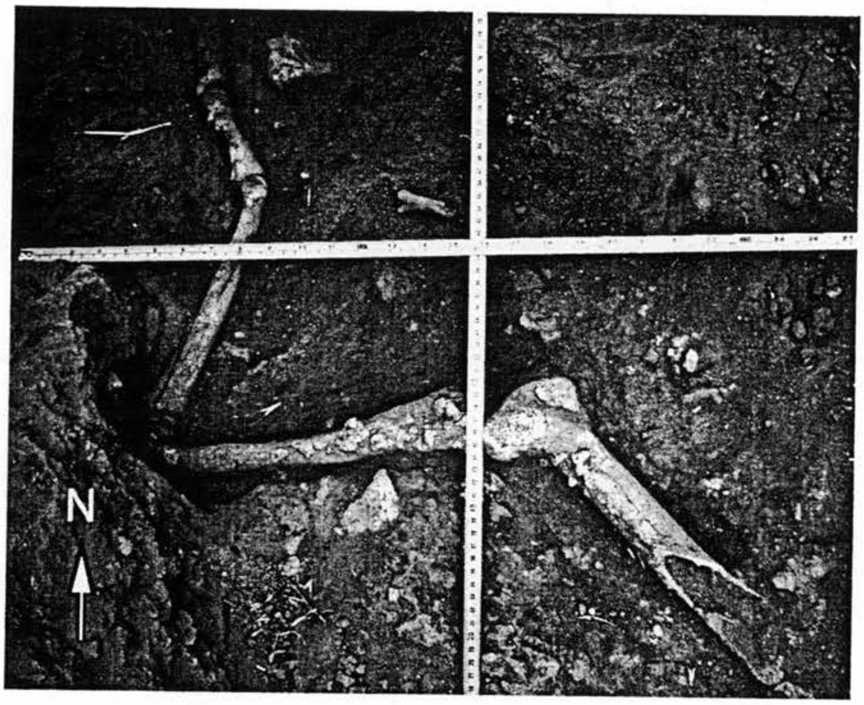



**Plate 5:** Equid (probably *Equus asinus*) leg found in articulation (distal femur through phalanx 3) from stratum IIb/IIIa at the Halif Terrace (Locus 65).

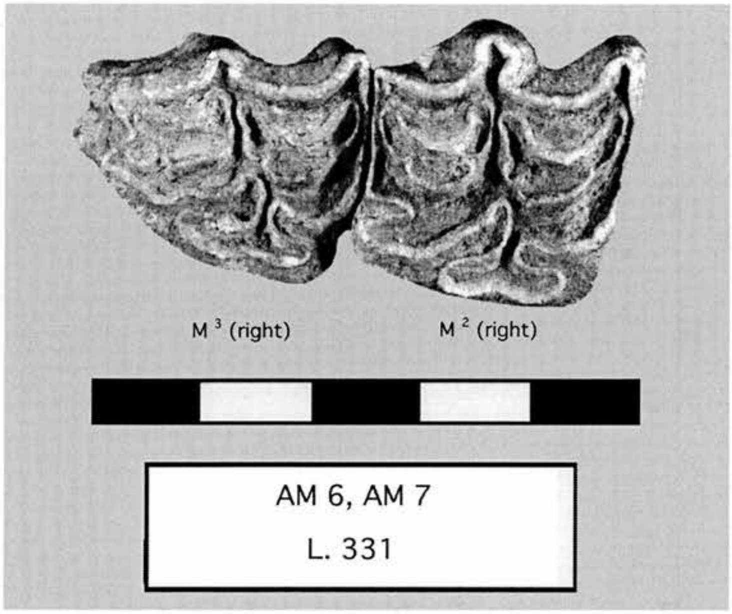



**Plate 6a:** Equid (probably *Equus asinus*) upper molars from Afridar Area E

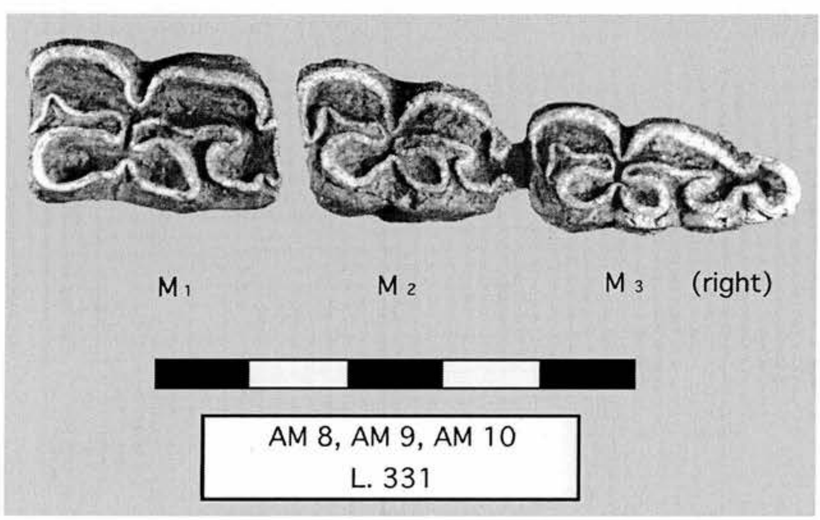



**Plate 6b:** Equid (probably *Equus asinus*) lower molars from Afridar Area E

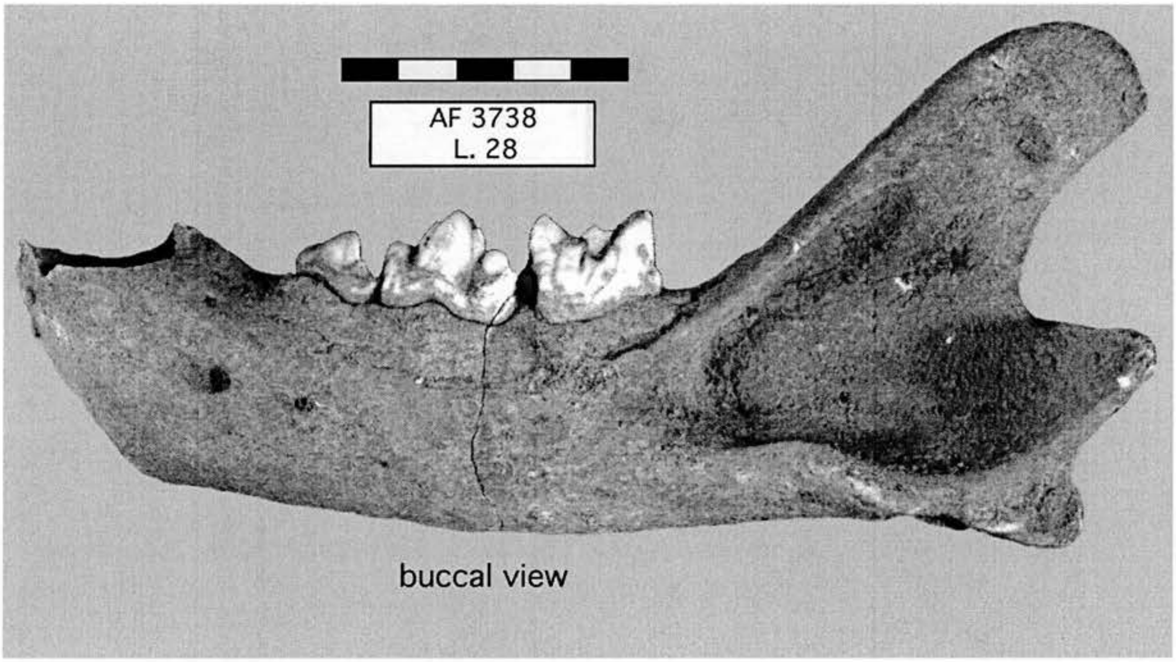



**Plate 7:** Complete left mandible of a lion (*Panthera leo*) from Afridar Area G

**Figure 1: Taxonomic Richness at Afridar G**

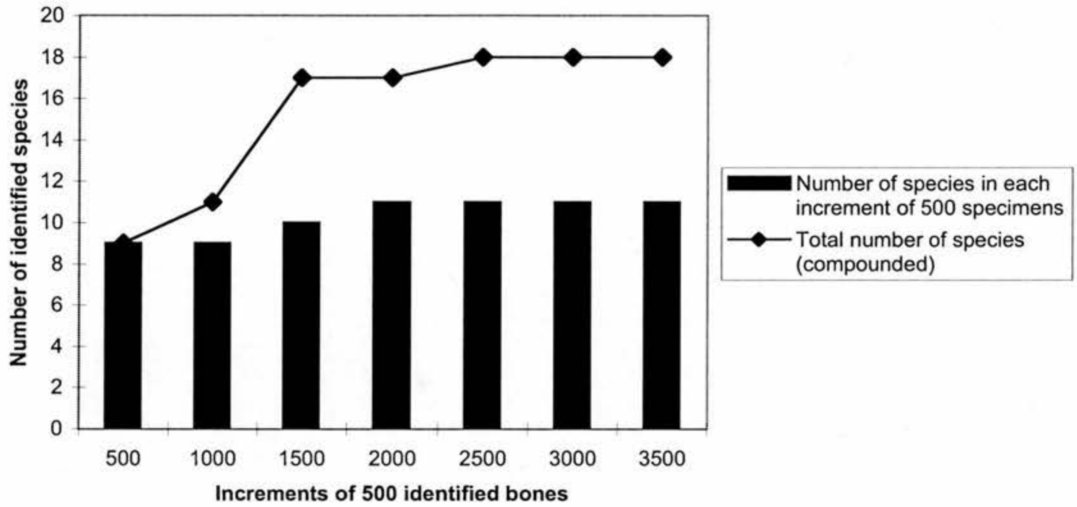
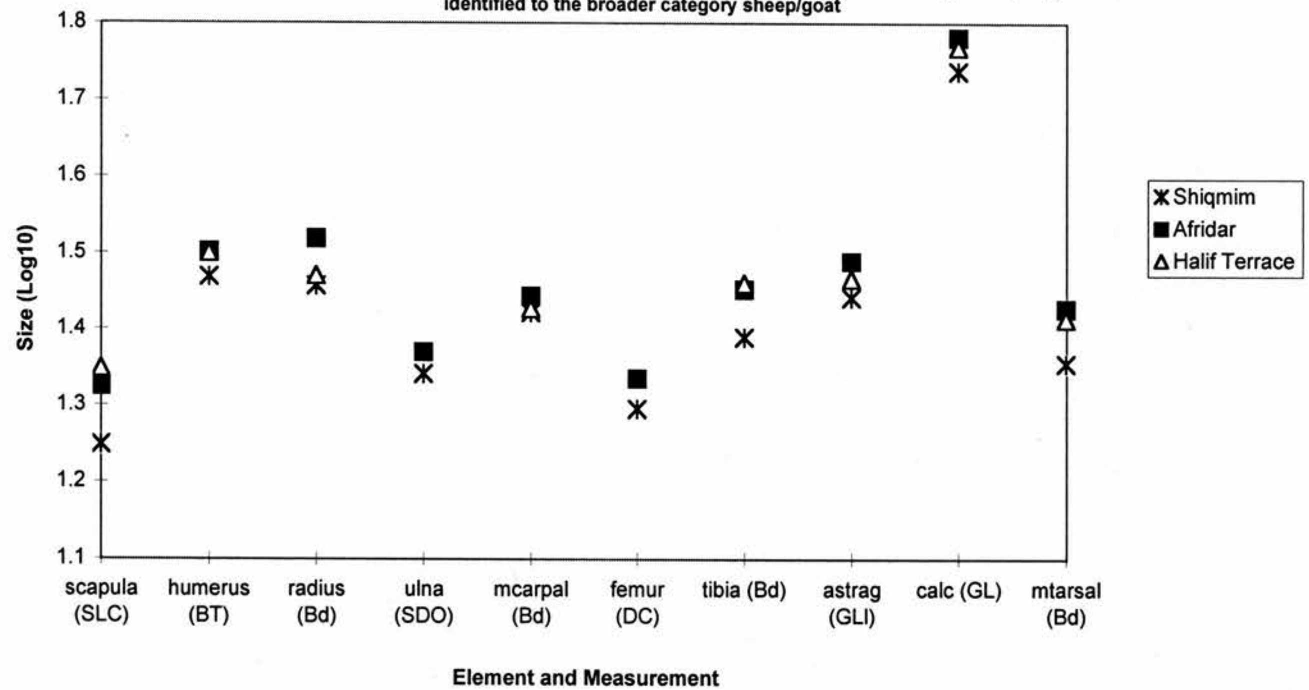
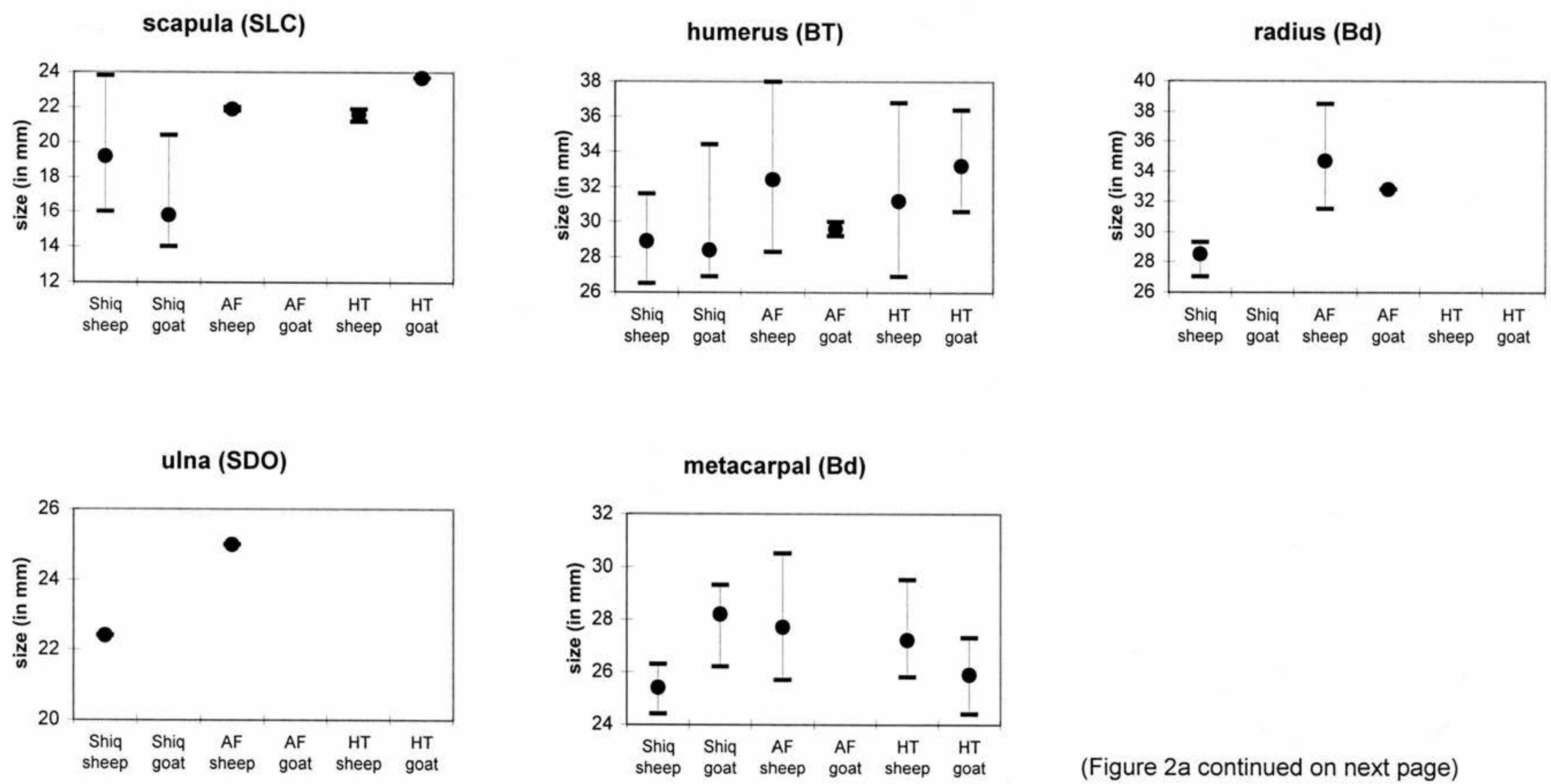


**Figure 2: Average size of sheep/goat* at all three sites**
(data from Tables 3a-3c)
***Note:** This table contains bones identified as coming from sheep, bones identified as coming from goat, *and* bones identified to the broader category sheep/goat



## Figure 2a: Average sheep and goat sizes at Shiqmim, Afridar, and the Halif Terrace

(Data from Sections II and III of Tables 3a, 3b, and 3c)




(Figure 2a continued on next page)

Figure 2a (cont.)

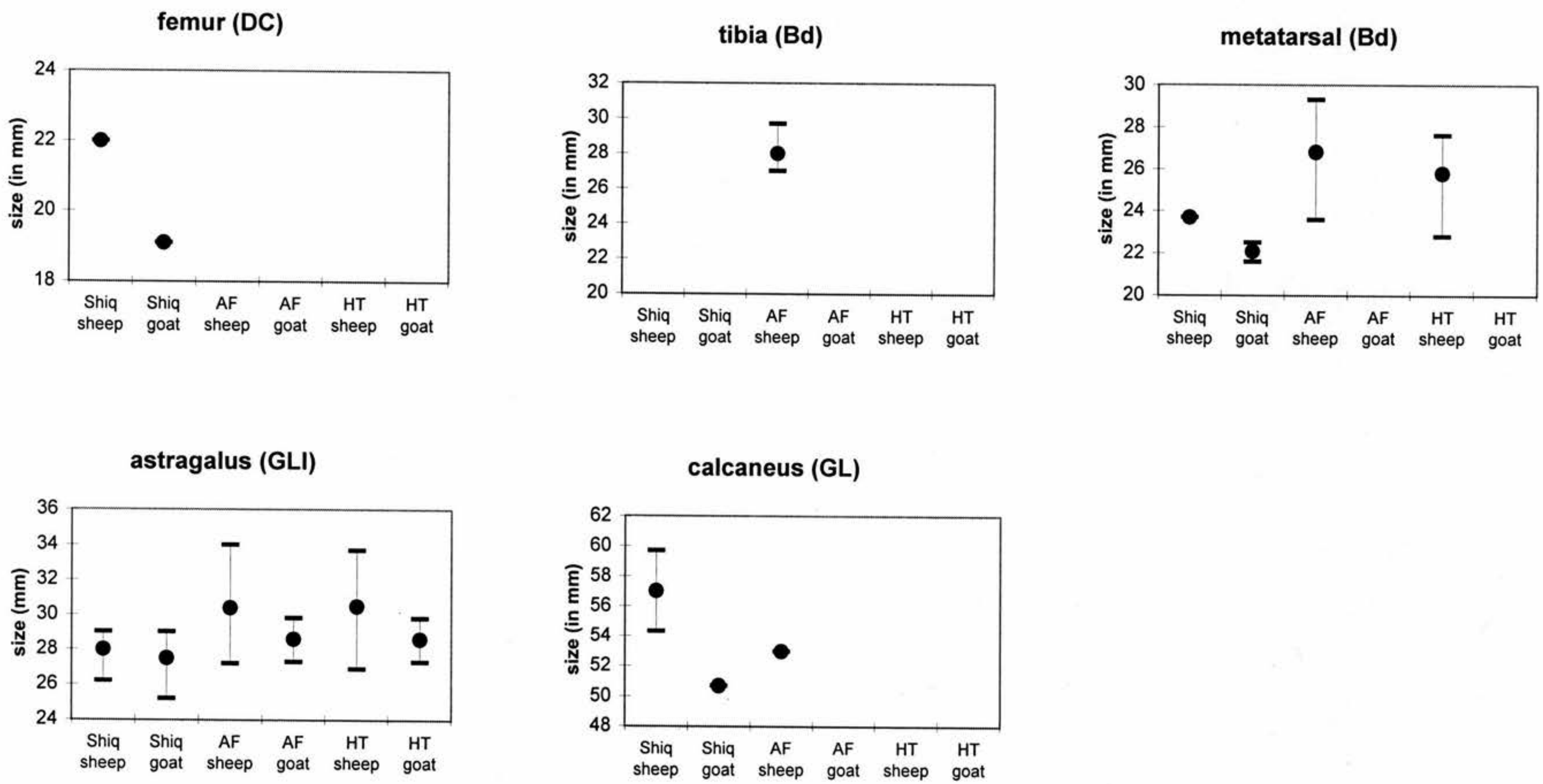


**Figure 2b: Average size of sheep at all three sites**
(data from Section II of Tables 3a-3c)

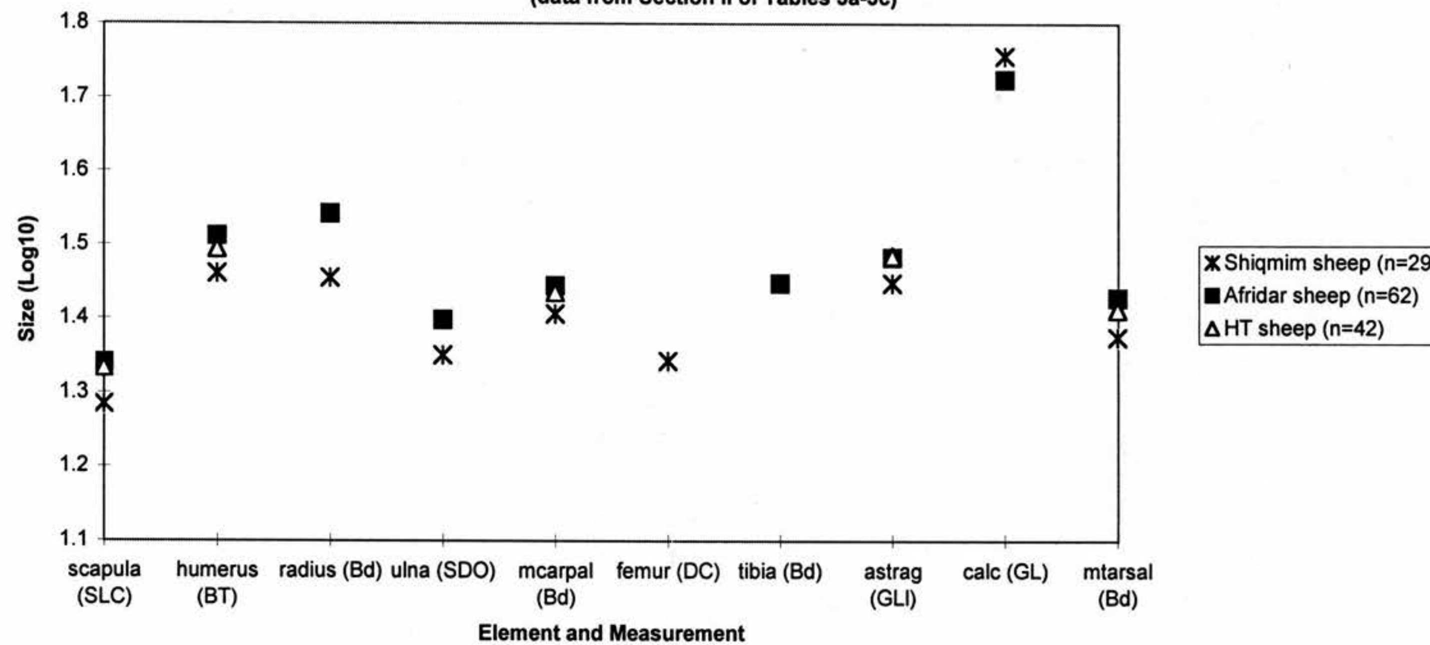
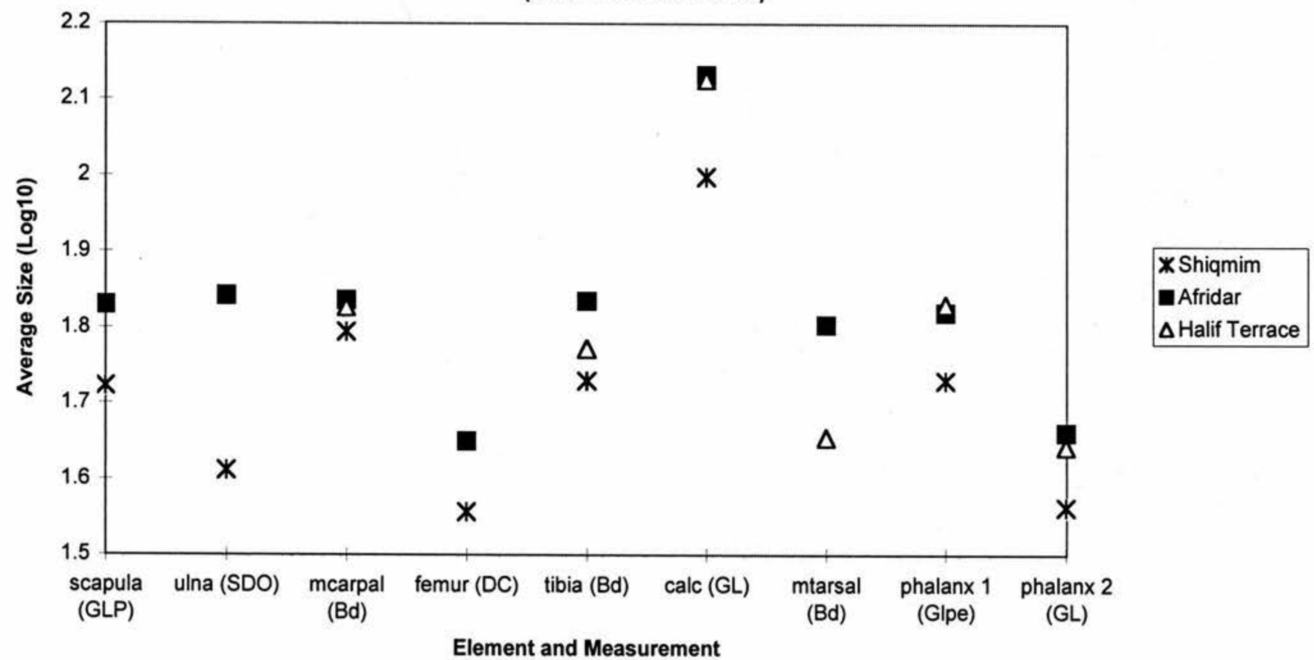
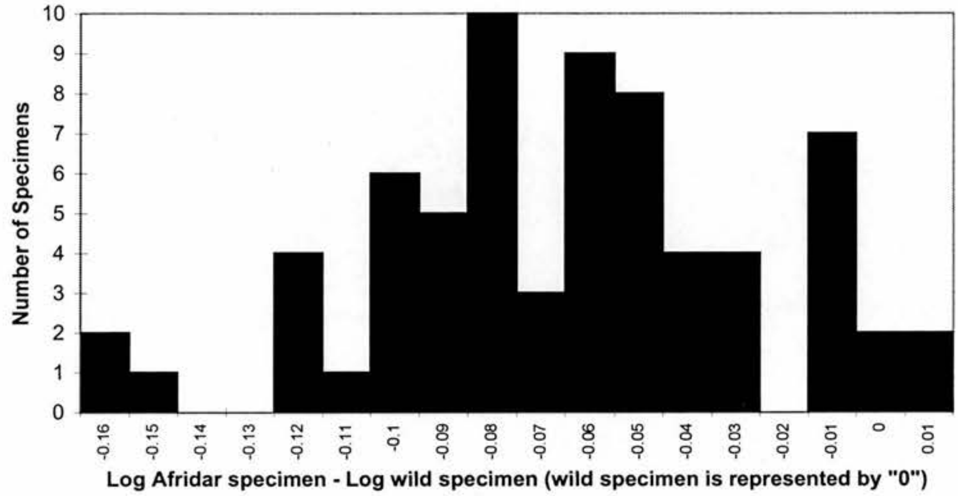


**Figure 3: Average size of cattle at all three sites**
(data from Tables 4a-4c)



## Figure 4: Cattle size at Afridar, compared with measurements from a known wild specimen, data from Table 5 (number of bones from Afridar=68)




## Figure 5: Cattle Size at the Halif Terrace, compared with measurements from a known wild specimen, data from Table 6 (number of bones from the Halif Terrace=27)

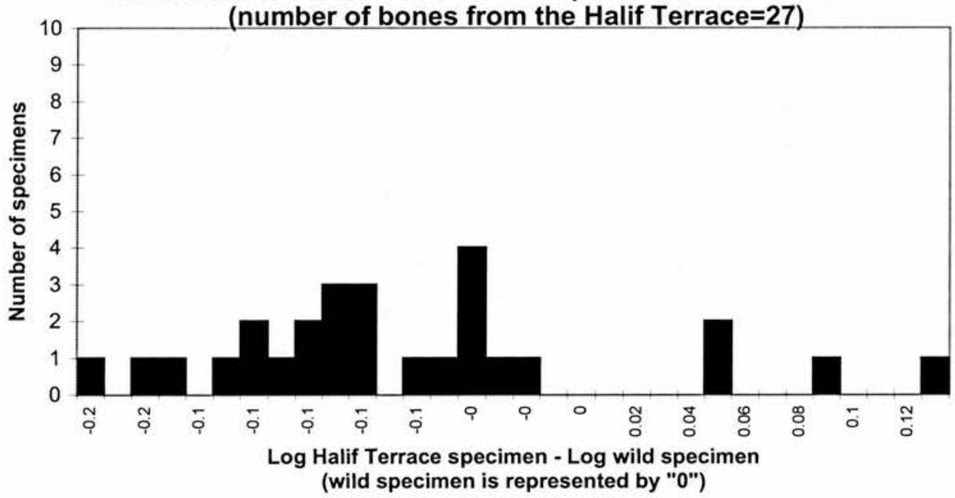


**Figure 6a: Distribution of pathologies on sheep/goat bones and teeth**

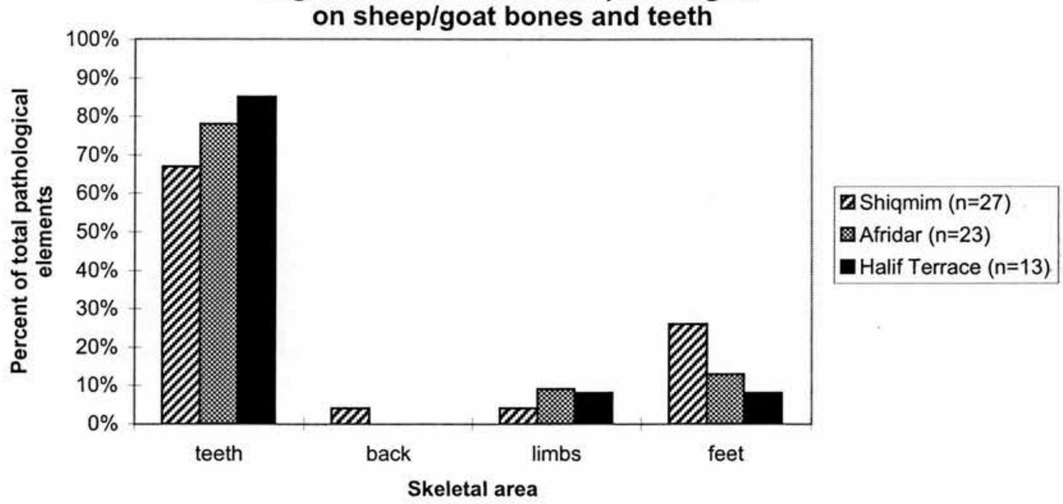



**Figure 6b: Distribution of pathologies on cattle bones and teeth**

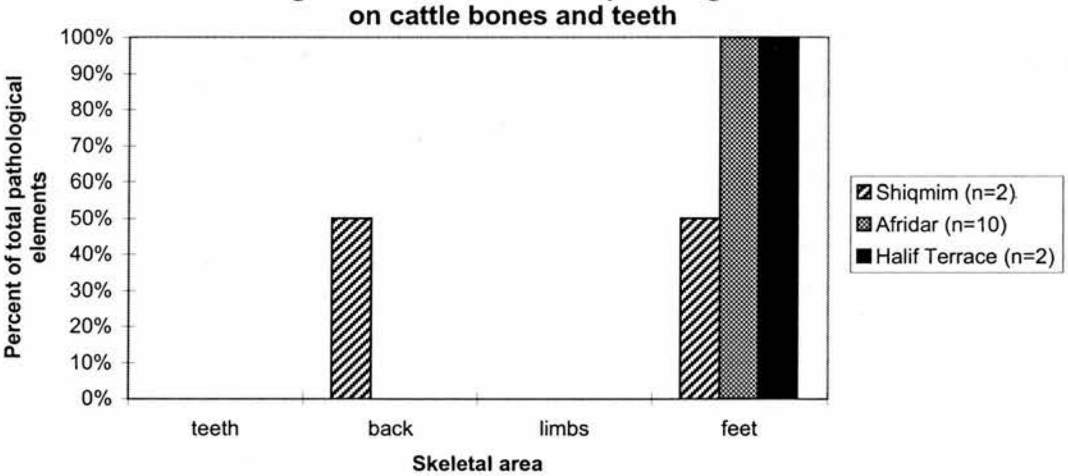


**Figure 7: Fragment sizes for the bones of domestic animals at Afridar G**

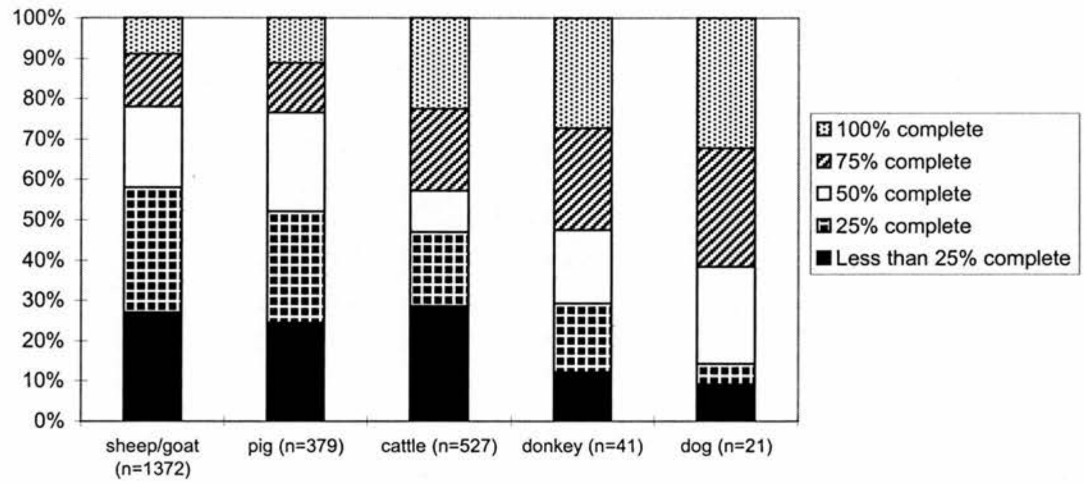



**Fig 8: Relative abundance of complete elements per taxon (expressed as a percentage of the total bones of each taxon) (data from Table 14)**

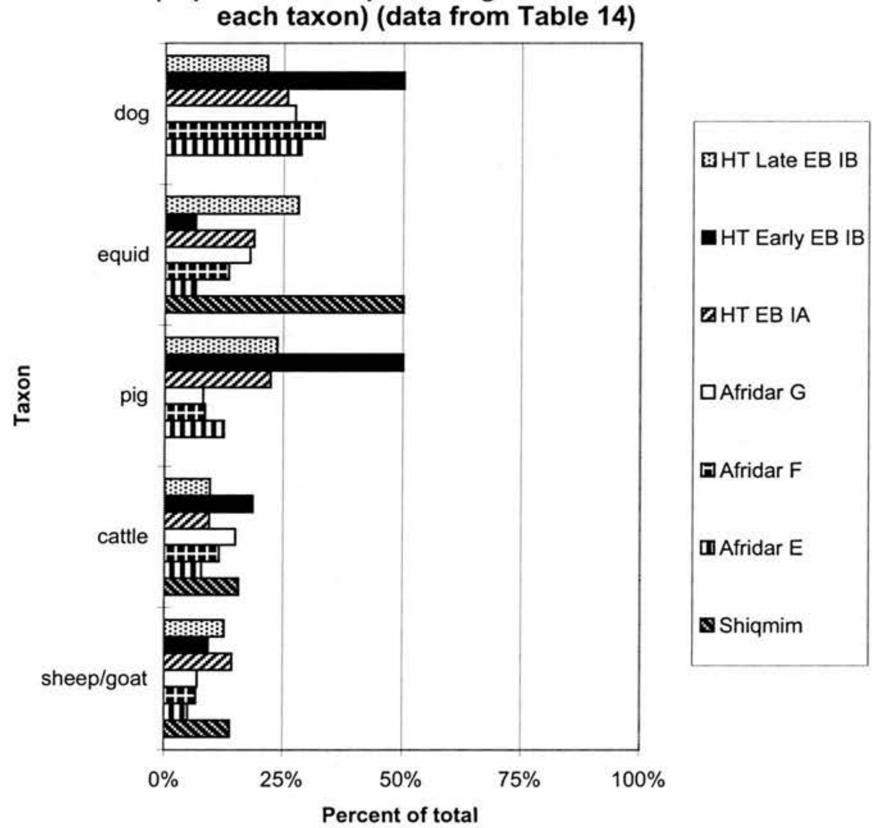


**Figure 9: Differential kill-off patterns for the primary objectives of meat, milk, and wool**

**Figure 9a: Killing for meat at optimum (and breeding selection), mainly males (from Payne, 1973)**

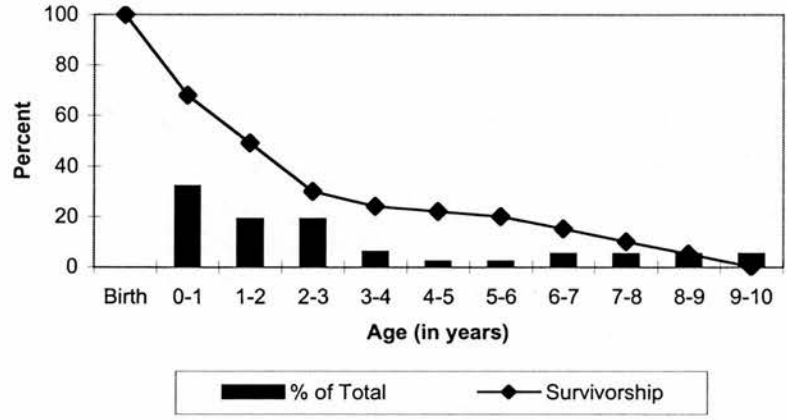



**Figure 9b: Killing for milk production (and breeding selection), lambs mostly male, breeding selection male and female (from Payne, 1973)**

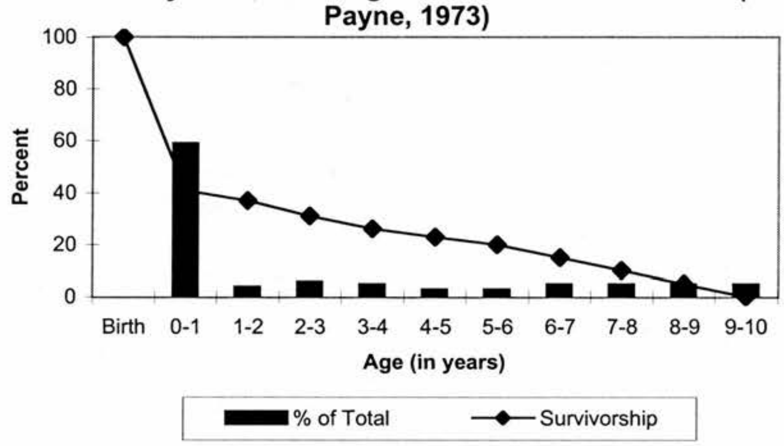



**Figure 9c: Killing for wool and breeding selection (mainly females killed) (from Payne 1973)**

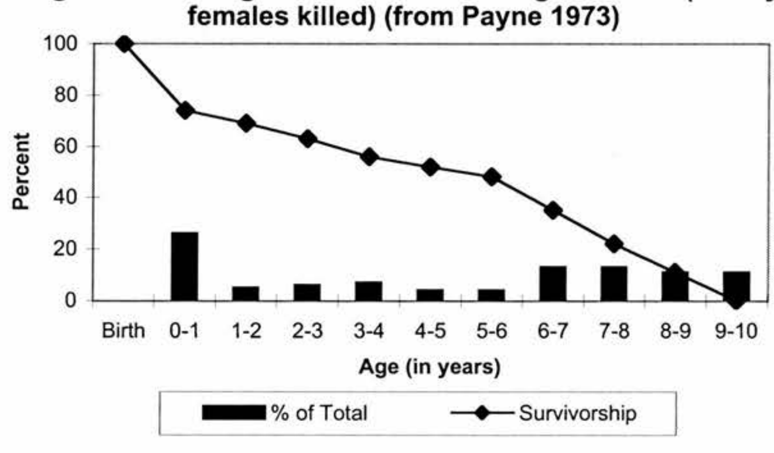


**Figure 10: Sheep/Goat Kill-Off at Shiqmim (n=52)**
**[based on mandibular tooth eruption and wear stages (Payne 1973)]**

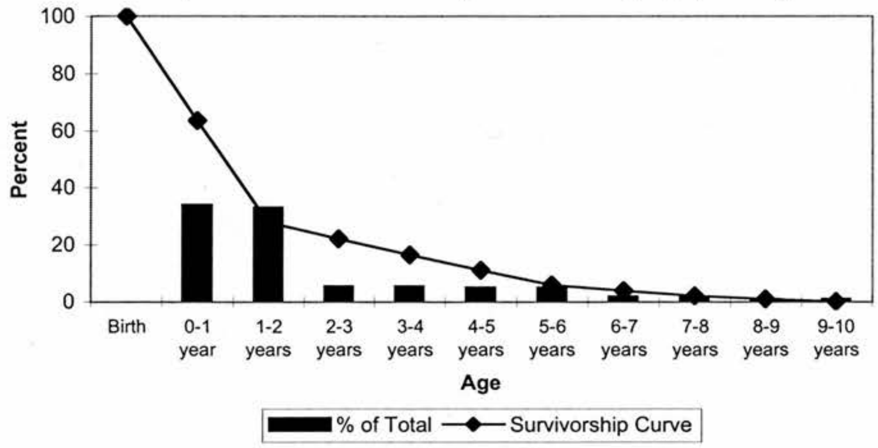



**Figure 11: Sheep/Goat Mortality at Shiqmim, based on bone fusion (data from Table 26)**

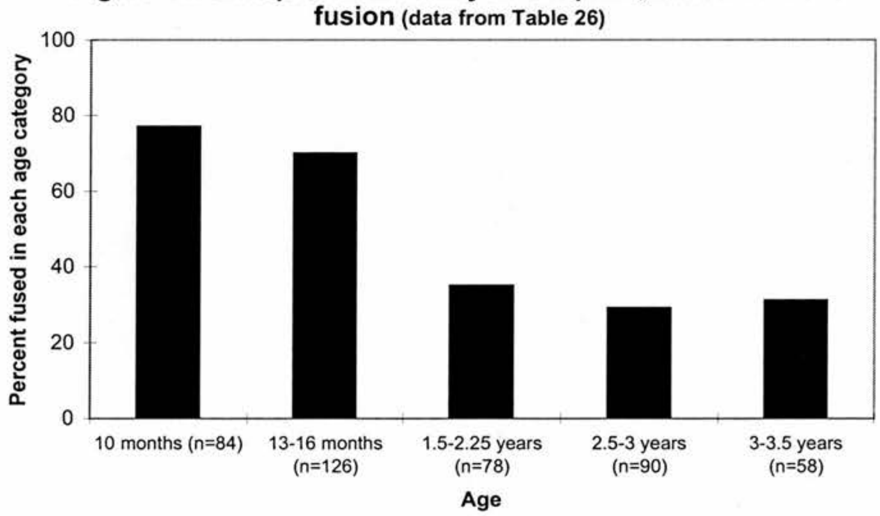


**Figure 12: Sheep/Goat Kill-Off at Afridar G (n=146)**
[based on mandibular tooth eruption and wear stages (Payne 1973)]

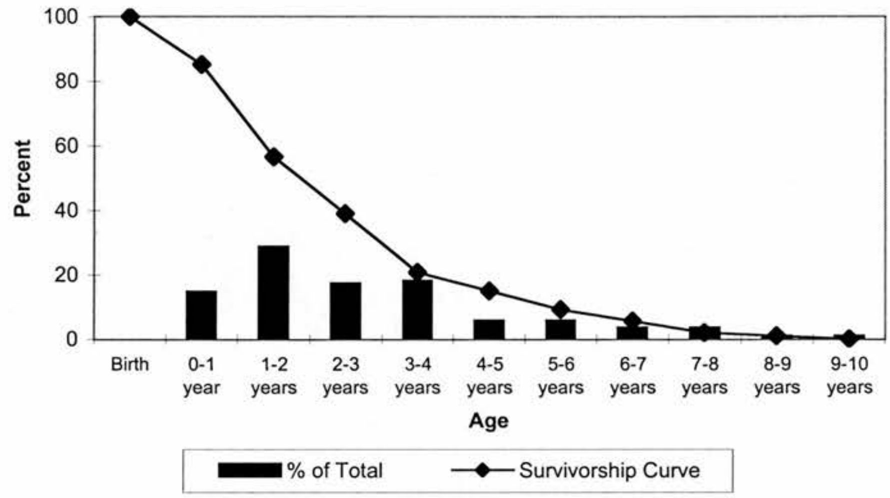



**Figure 13: Sheep/Goat Mortality at Afridar, based on bone fusion** (data from Table 27)

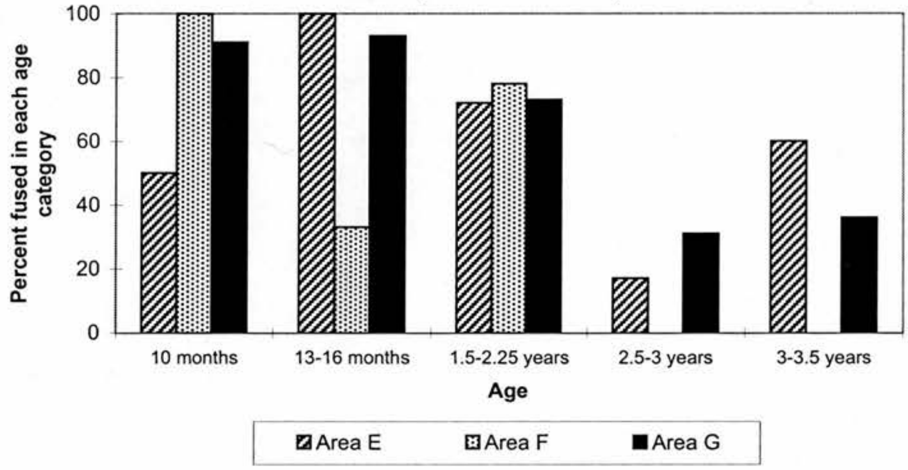


**Figure 14:** Sheep/Goat Kill-Off in the EB IA at the Halif Terrace (n=16)
[based on mandibular tooth eruption and wear stages (Payne 1973)]

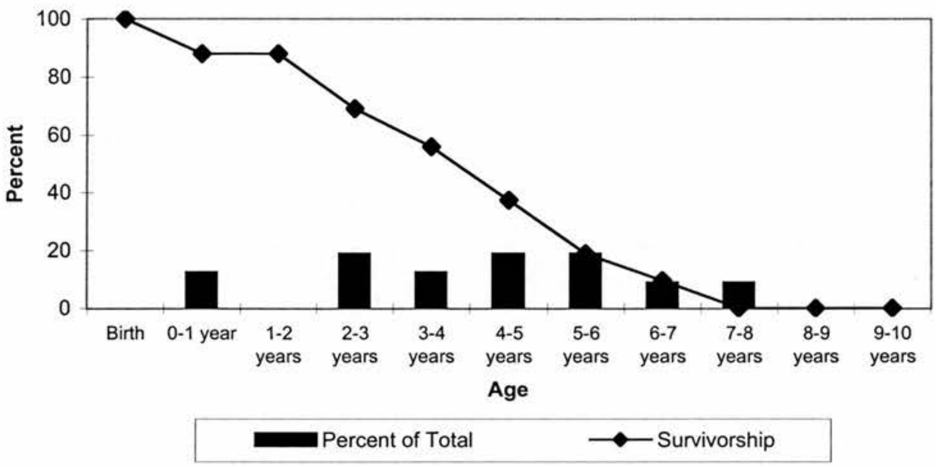



**Figure 15: Sheep/Goat Mortality during the EB IA at the Halif Terrace, based on bone fusion**
(data from Table 28)

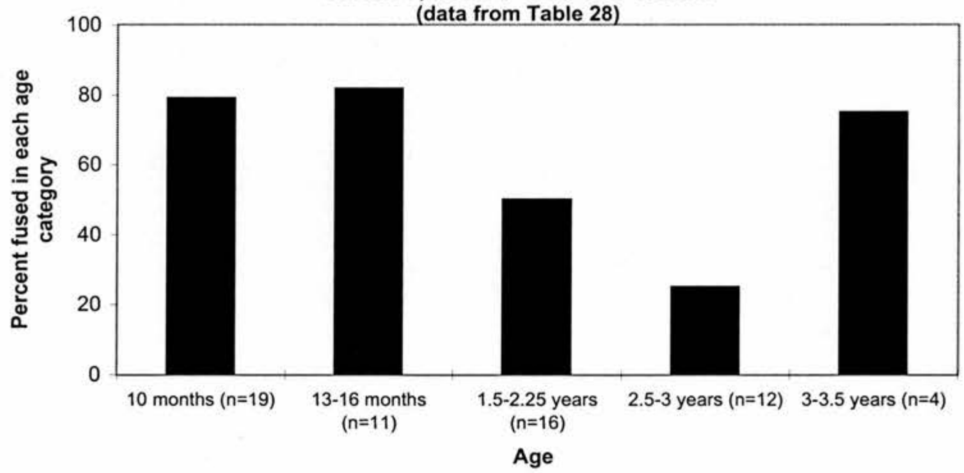


**Figure 16:** Sheep/Goat Kill-Off in the Early EB IB at the Halif Terrace (n=7) [based on mandibular tooth eruption and wear stages (Payne 1973)]

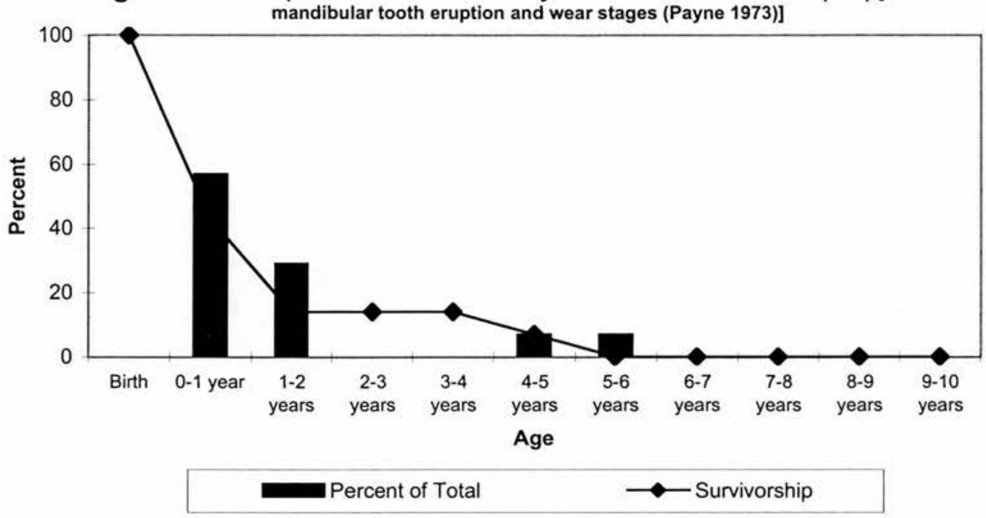



**Figure 17 : Sheep/Goat Mortality during the Early EB IB at the Halif Terrace, based on bone fusion**
(data from Table 28)

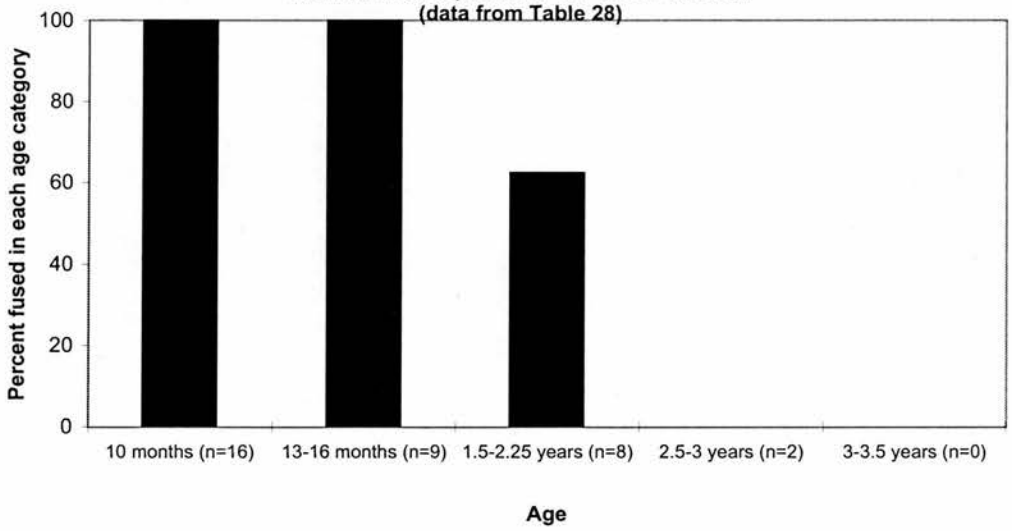


**Figure 18:** Sheep/Goat Kill-Off in the Late EB IB at the Halif Terrace (n=43) [based on mandibular tooth eruption and wear stages (Payne 1973)]

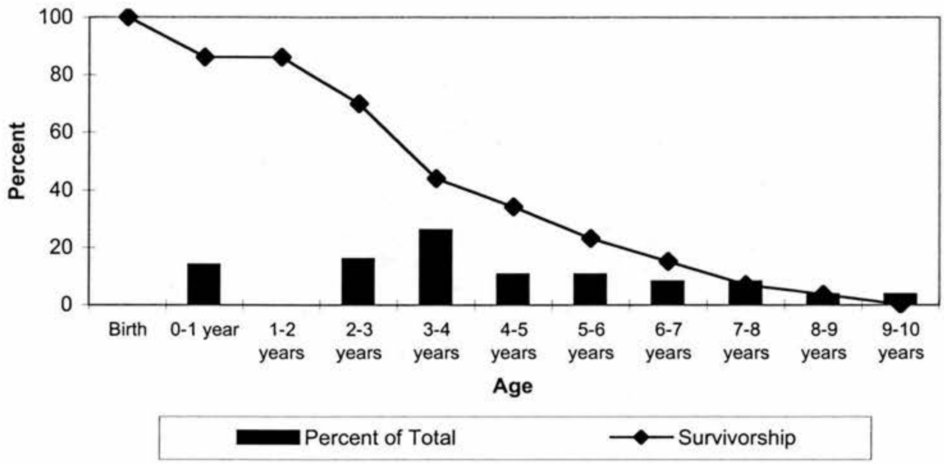



**Figure 19 : Sheep/Goat Mortality from the Late EB IB at the Halif Terrace, based on bone fusion**
(data from Table 28)

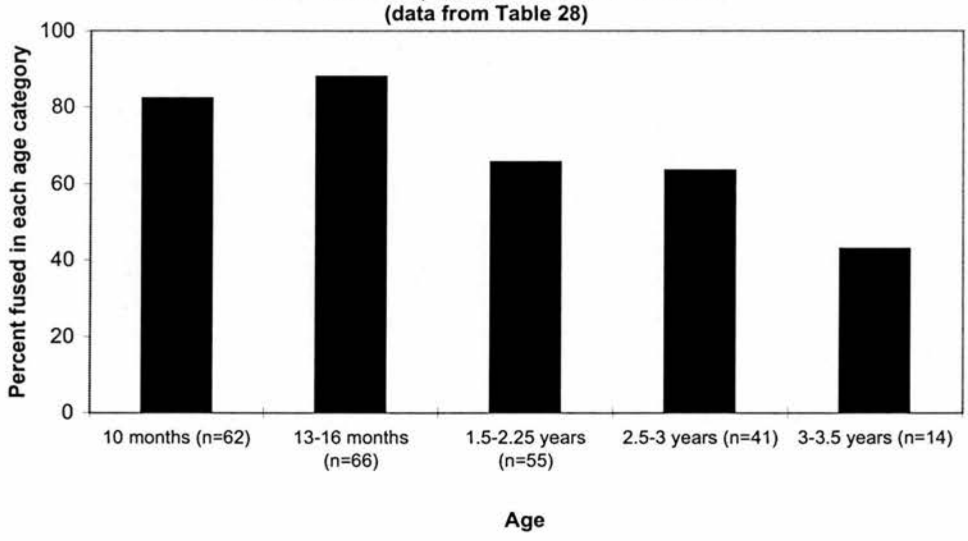


Figure 20: Cattle mortality at Shiqmim, based on bone fusion data (data from Table 26)

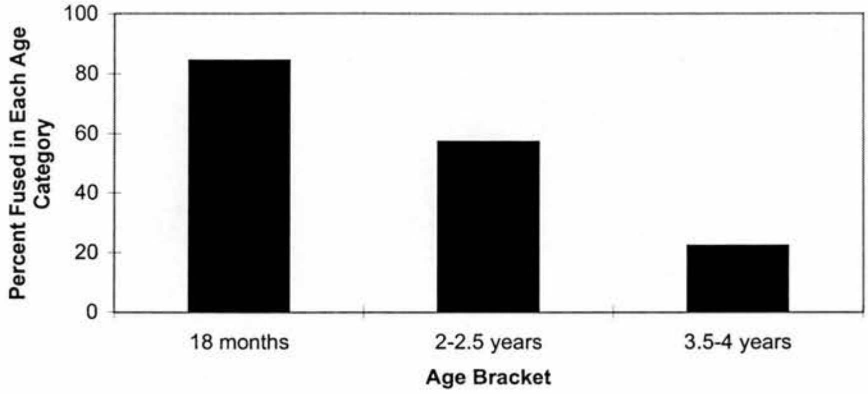



Figure 21: Cattle Mortality at Afridar, based on bone fusion data (data from Table 27)

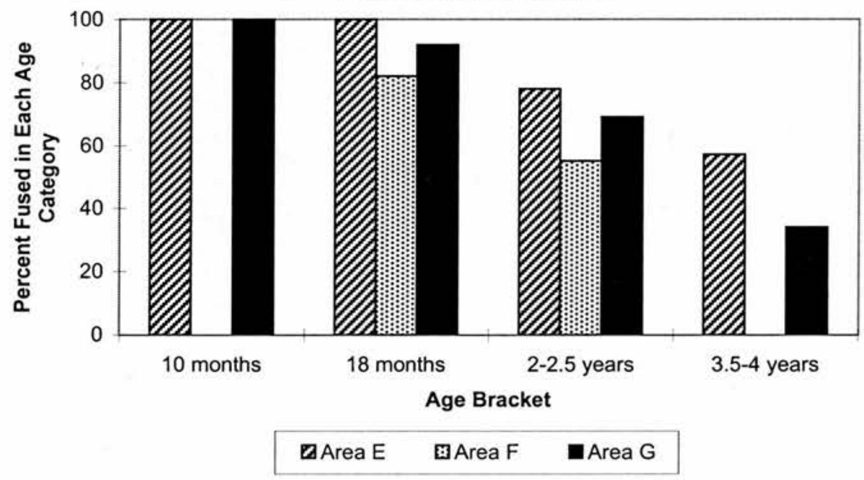


**Figure 22: Cattle Mortality during the Late EB IB at the Halif Terrace, based on bone fusion**
(data from Table 28)

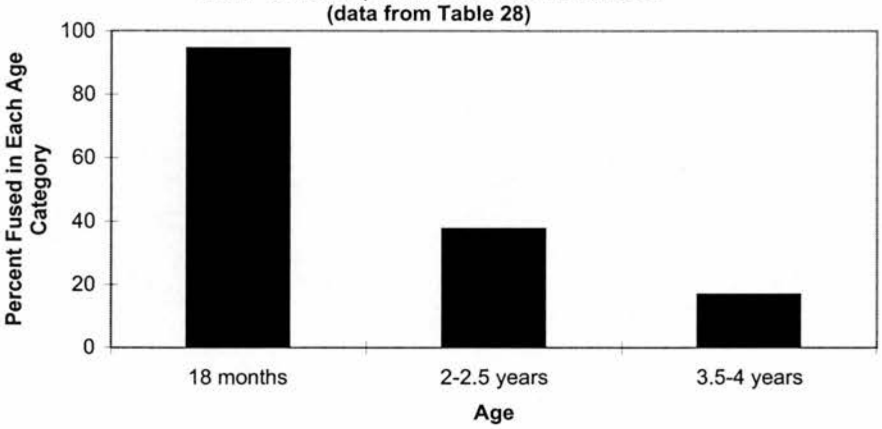



**Figure 23: Pig Mortality at Afridar, based on bone fusion** (data from Table 27)

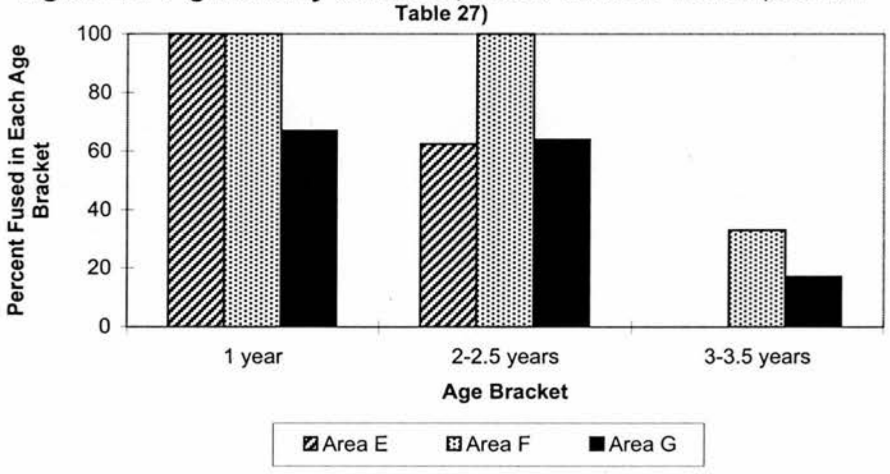


**Figure 24: Equids from the Levant and Egypt, after Grigson (1993)**
**[Left (open squares): wild onager measurements from Shams ed-Din; Right (open triangles): horse measurements from 2nd millennium Egypt and 4th-3rd millennium Anatolia]**

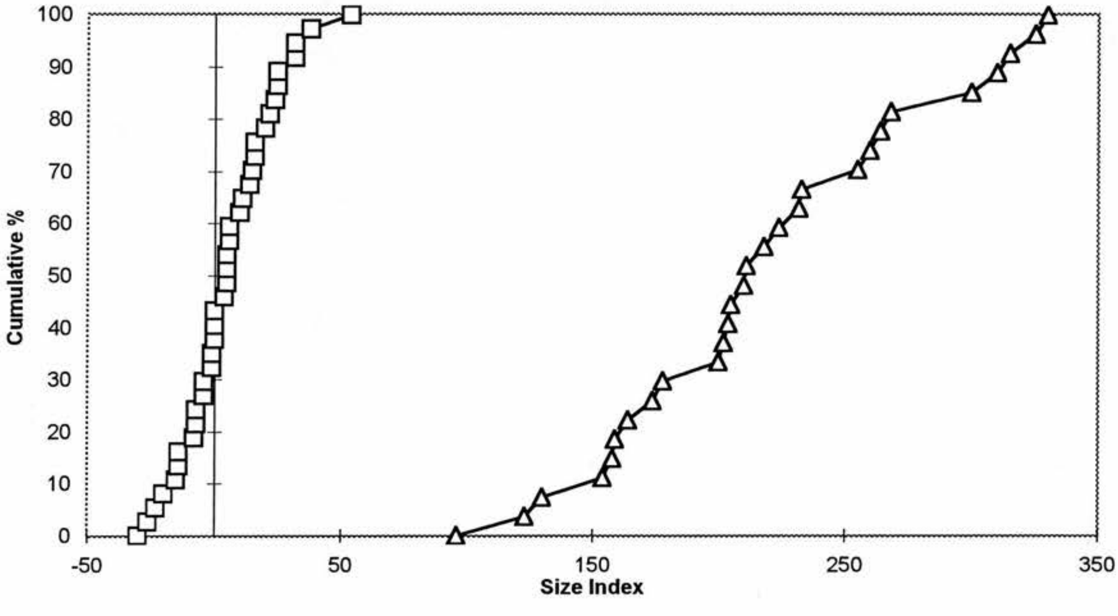


Figure 25: The size of the equids from Afridar Area E (n=12)

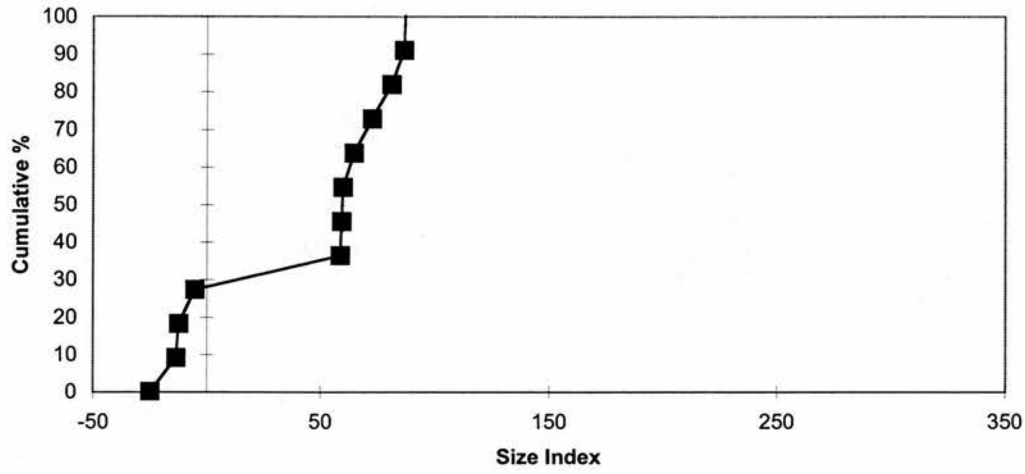



Figure 26: The smaller and larger of the 12 equid bones from Afridar F, plotted separately

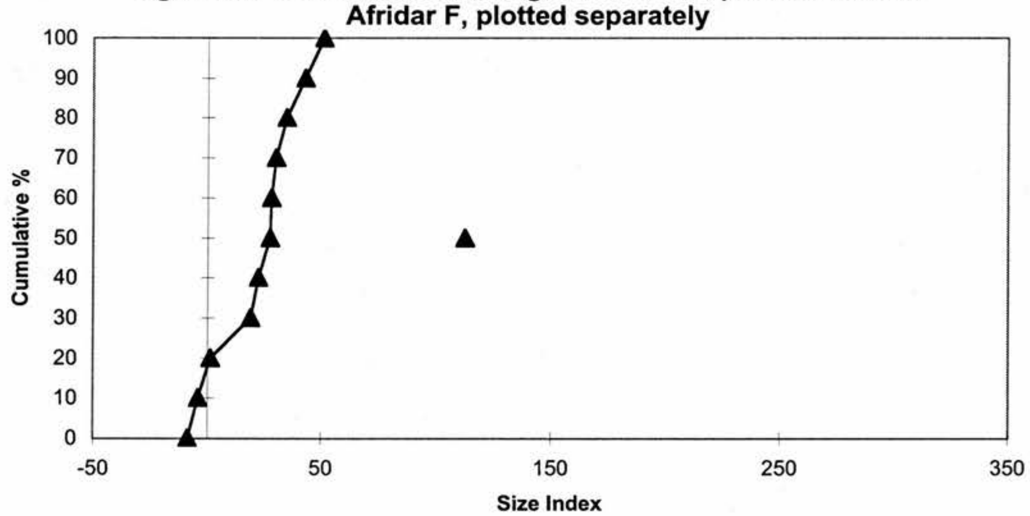


Figure 27: The smaller and larger of the 13 equid bones from Afridar G, plotted separately

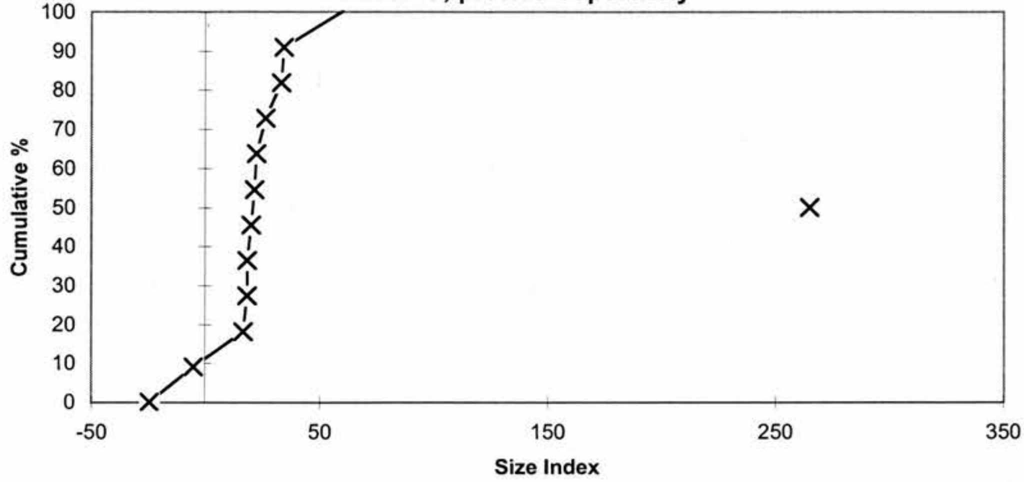



Figure 28: The smaller and larger of the 37 equid bones from all areas of Afridar (E,F, and G), plotted separately

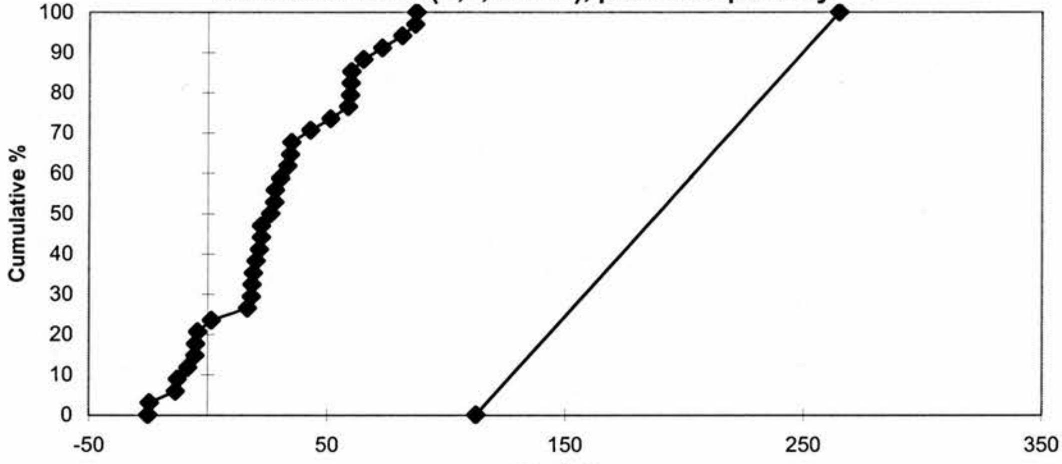


**Figure 29: The size of the equids from the Halif Terrace (n=23)**

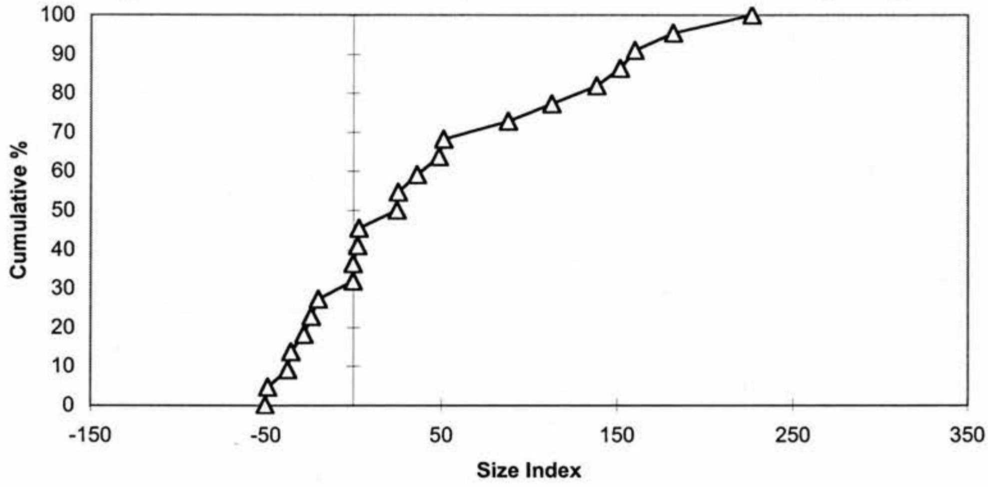



**Figure 30: The smaller and larger of the 23 equid bones from the Halif Terrace, plotted separately**

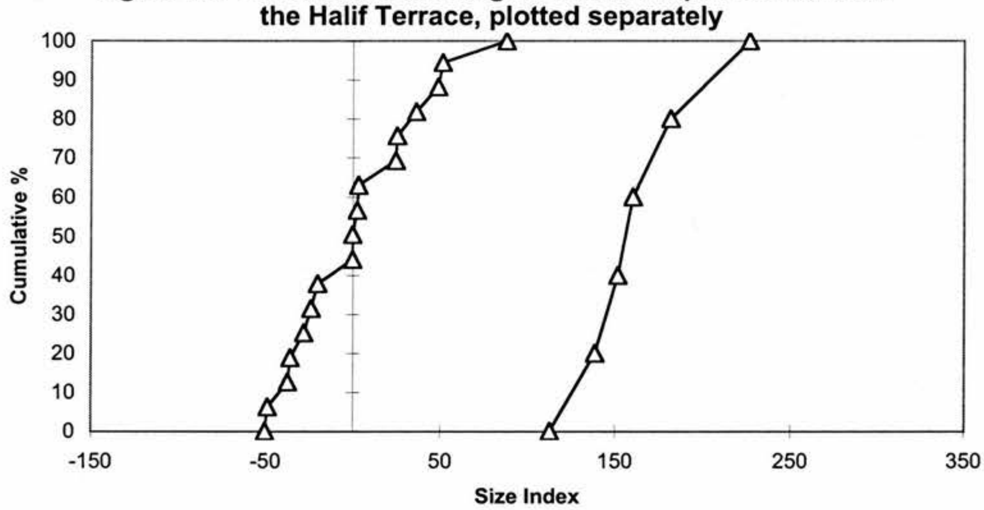


**Figure 31: All equid measurments from Shiqmim, Afridar E, F, and G, and the Halif Terrace** (plotted with known onager and horse measurements)

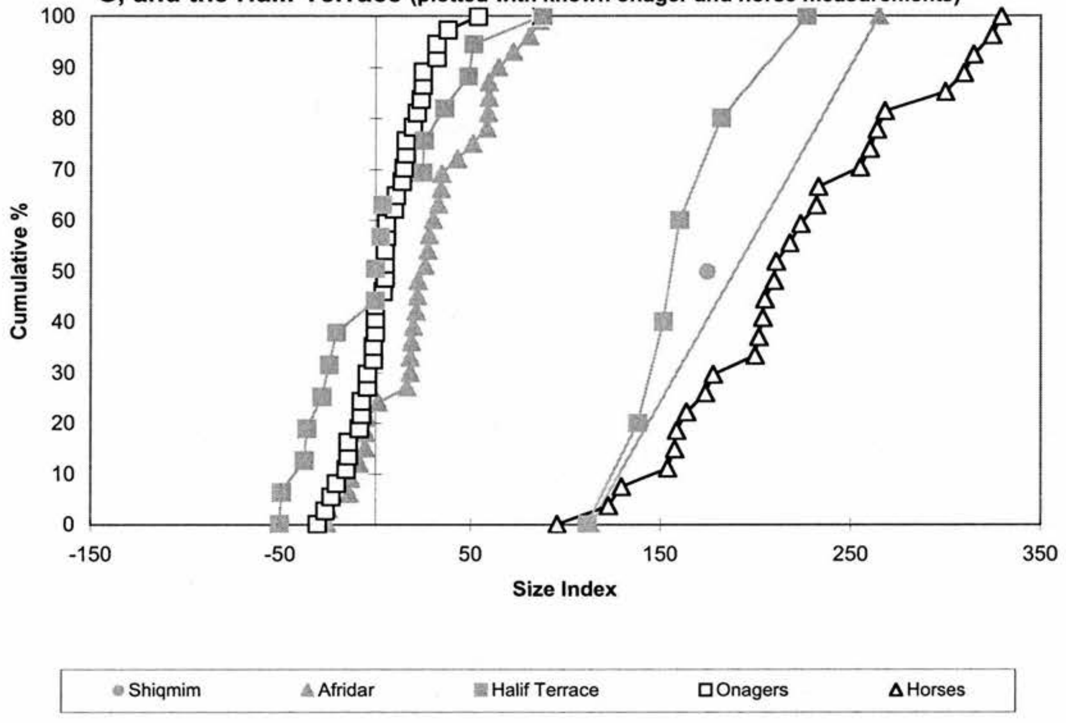
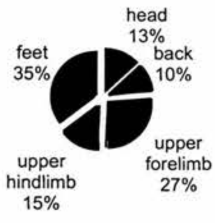


**Figure 32: Body Part Representation for Cattle, Sheep/Goat, Pig, and Equid at Shiqmim, Afridar, and the Halif Terrace**
**(based on adjusted data, given in Tables 36a-36e)**

**Body Part Representation for Shiqmim Cattle**
**(data from Table 36a)**




**Body Part Representation for Shiqmim Sheep/Goat**
**(data from Table 36a)**

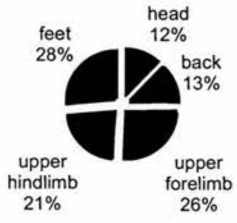
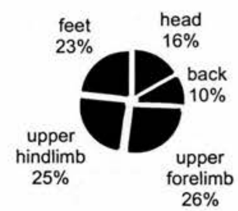


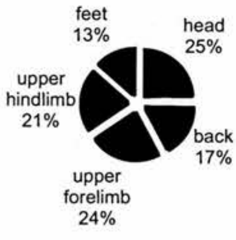
Figure 32 (cont.)

**Body Part Representation for Afridar Area E Cattle**
**(data from Table 36b)**


**Body Part Representation for Afridar Area E Sheep/Goat**
**(data from Table 36b)**




**Body Part Representation for Afridar Area E Pigs**
**(data from Table 36b)**




**Body Part Representation for Afridar Area E Equids**
**(data from Table 36b)**

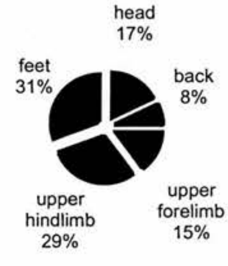
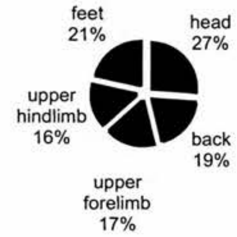


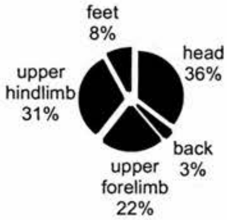
Figure 32 (cont.)

**Body Part Representation for Afridar Area F Cattle**
**(data from Table 36c)**


**Body Part Representation for Afridar Area F Sheep/Goat**
**(data from Table 36c)**




**Body Part Representation for Afridar Area F Pigs**
**(data from Table 36c)**




**Body Part Representation for Afridar Area F Equids**
**(data from Table 36c)**

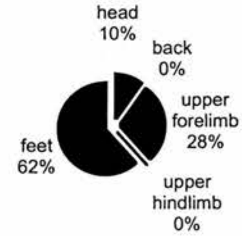
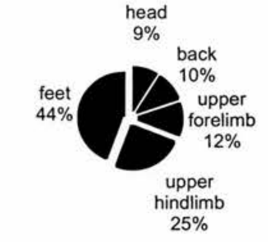
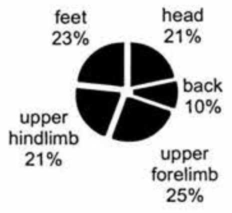


Figure 32 (cont.)

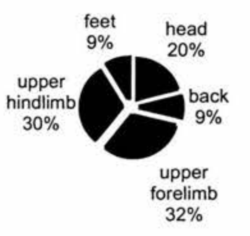
**Body Part Representation for Afridar Area G Cattle**
**(data from Table 36d)**




**Body Part Representation for Afridar Area G Sheep/Goat**
**(data from Table 36d)**




**Body Part Representation for Afridar Area G Pigs**
**(data from Table 36d)**




**Body Part Representation for Afridar Area G Equids**
**(data from Table 36d)**

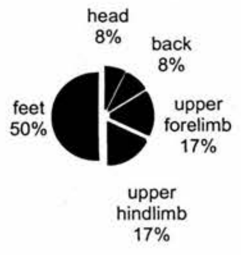
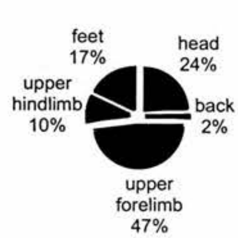


Figure 32 (cont.)

**Body Part Representation for Halif Terrace Cattle**
**(data from Table 36e)**


**Body Part Representation for Halif Terrace Sheep/Goat**
**(data from Table 36e)**


**Body Part Representation for Halif Terrace Pigs**
**(data from Table 36e)**




**Body Part Representation for Halif Terrace Equids**
**(data from Table 36e)**

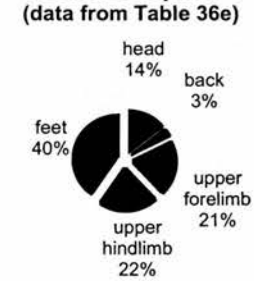


**Table 1**

Richness of taxa represented in the Shiqmim, Afridar, and Halif Terrace (HT) assemblages

| Site | Total # of different taxa (S) | Total # of bones (N) | Species Richness ($d=S-1/\log_e N$) |
|---|---|---|---|
| **Afridar G** | 19 | 3277 | **2.22** |
| **Afridar F** | 13 | 303 | **2.10** |
| **Afridar E** | 13 | 527 | **1.91** |
| **HT EB IA** | 12 | 325 | **1.90** |
| **HT Late EB IB** | 14 | 1117 | **1.85** |
| **HT Early EB IB** | 10 | 191 | **1.71** |
| **Shiqmim** | 12 | 1558 | **1.50** |

**Table 2**

The taxa present in the Shiqmim, Afridar, and Halif Terrace faunal assemblages

| | | SHIQMIM | AFRIDAR | | | Halif Terrace | | |
|---|---|---|---|---|---|---|---|---|
| **Domestic animals:** | | | Area E | Area F | Area G | EB IA | Early EB IB | Late EB IB |
| sheep | *Ovis aries* | p | p | p | p | p | p | p |
| goat | *Capra hircus* | p | p | p | p | p | p | p |
| cattle | *Bos taurus* | p | p | p | p | p | p | p |
| pig | *Sus scrofa* | – | p | p | p | p | p | p |
| donkey | *Equus asinus* | – | p | p | p | p | p | p |
| horse | *Equus caballus* | p | p | p | p | p | – | p |
| dog | *Canis domesticus* | p | p | p | p | p | p | p |
| **Wild animals:** | | | | | | | | |
| gazelle | *Gazella* sp. | p | p | p | p | p | p | p |
| wild cow | *Bos primigenius* | – | – | – | p | p | p | p |
| hartebeest | *Alcelaphus buselaphus* | – | – | p | p | p | p | p |
| fallow deer | *Dama dama* | – | – | – | p | – | – | – |
| red deer | *Cervus elaphus* | – | – | p | p | – | – | – |
| roe deer | *Capreolus capreolus* | – | p | p | p | – | – | – |
| wild pig | *Sus scrofa* | – | – | – | – | – | p | p |
| lion | *Panthera leo* | – | – | – | p | – | – | – |
| cat (domestic?) | *Felis* sp. | p | – | – | p | p | – | – |
| hyaena | *Hyaena hyaena* | – | p | – | – | – | – | – |
| fox | *Vulpes vulpes* | p | p | – | – | – | – | p |
| hare | *Lepus* sp. | p | – | – | – | – | – | – |
| rodent | Rodentia | p | p | – | p | p | – | – |
| ostrich | *Struthio camelus* | – | – | – | – | – | – | p |
| bird | | p | p | p | p | p | – | p |
| fish | | p | p | p | p | – | – | – |
| frog | | p | – | – | – | – | – | – |
| crocodile | *Crocodilius niloticus* | – | – | – | p | – | – | – |
| sea turtle | | – | – | – | p | – | – | – |
| **Total taxa:** | | **12** | **13** | **13** | **19** | **12** | **10** | **14** |
| **Total Bones in Identified Assemblage:** | | **1558** | **527** | **303** | **3277** | **325** | **191** | **1117** |

**Table 3a**

Measurements (in mm) of fused sheep and goat bones from Shiqmim

**Section I:** Measurements of fused sheep/goat bones from Shiqmim
(this section includes bones identified as sheep, bones identified as goat, and bones identified as "sheep/goat")

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 14.23.8 | 26.9-34.4 | 27-29.3 | 18.5-23.4 | 24.4-29.3 | 18.8-22 | 22.4-27.2 | 21.6-23.7 | 23.5-30.5 | 50.7-59.7 |
| **Mean** | **17.7** | **29.4** | **28.6** | **21.9** | **26.4** | **19.7** | **24.7** | **22.6** | **27.6** | **54.6** |
| Data | 14 | 26.5 | 27 | 18.5 | 24.4 | 18.8 | 22.4 | 21.6 | 23.5 | 50.7 |
| | 14.8 | 26.9 | 28.7 | 22.4 | 24.6 | 19.1 | 23.3 | 22.5 | 25.2 | 52.2 |
| | 15 | 27 | 28.8 | 23.2 | 25.4 | 19.1 | 24.8 | 23.7 | 26.2 | 54.3 |
| | 15 | 27.5 | 29 | 23.4 | 25.9 | 19.2 | 24.8 | | 26.6 | 55.9 |
| | 15.3 | 27.5 | 29.3 | | 26 | 19.7 | 25.7 | | 26.7 | 59.7 |
| | 15.8 | 27.8 | | | 26.2 | 20 | 27.2 | | 26.9 | |
| | 16 | 28.5 | | | 26.3 | 22 | | | 27 | |
| | 16.5 | 28.7 | | | 29 | | | | 27.3 | |
| | 16.8 | 28.9 | | | 29.3 | | | | 27.7 | |
| | 16.9 | 29 | | | | | | | 27.8 | |
| | 16.9 | 29.8 | | | | | | | 28.3 | |
| | 17 | 30.2 | | | | | | | 28.7 | |
| | 17.4 | 30.6 | | | | | | | 28.8 | |
| | 18.7 | 31.3 | | | | | | | 29 | |
| | 19.1 | 31.4 | | | | | | | 29 | |
| | 19.3 | 31.6 | | | | | | | 29 | |
| | 19.7 | 32.2 | | | | | | | 29.4 | |
| | 19.8 | 34.4 | | | | | | | 30.5 | |
| | 20.3 | | | | | | | | | |
| | 20.4 | | | | | | | | | |
| | 21.6 | | | | | | | | | |
| | 23.8 | | | | | | | | | |

**Section II:** Measurements of fused **sheep** bones from Shiqmim
(these bones are also included in Section I)

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 16-23.8 | 26.5-31.6 | 27-29.3 | 22.4 | 24.4-26.3 | 22 | | 23.7 | 26.2-29 | 54.3-59.7 |
| **Mean** | **19.2** | **28.9** | **28.5** | **22.4** | **25.4** | **22** | | **23.7** | **28** | **57** |
| Data | 16 | 26.5 | 27 | 22.4 | 24.4 | 22 | | 23.7 | 26.2 | 54.3 |
| | 17 | 27.5 | 28.7 | | 24.6 | | | | 27.7 | 59.7 |
| | 19.1 | 29.8 | 28.8 | | 25.9 | | | | 29 | |
| | 19.3 | 31.6 | 29.3 | | 26 | | | | 29 | |
| | 19.7 | | | | 26.3 | | | | | |
| | 19.8 | | | | | | | | | |
| | 23.8 | | | | | | | | | |

**Section III:** Measurements of fused **goat** bones from Shiqmim
(these bones are also included in Section I)

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | | | | | | | | | | |
| **Mean** | **15.8** | **28.4** | **0** | **0** | **28.2** | **19.1** | **0** | **22.1** | **27.5** | **50.7** |
| Data | 14 | 26.9 | | | 26.2 | 19.1 | | 21.6 | 25.2 | 50.7 |
| | 14.8 | 27.5 | | | 29 | | | 22.5 | 26.7 | |

Table 3a (cont.)

| | | | | |
|---|---|---|---|---|
| | 15 | 27.8 | 29.3 | 27 |
| | 15.8 | 28.5 | | 28.3 |
| | 16.8 | 28.7 | | 28.8 |
| | 16.9 | 28.9 | | 29 |
| | 17.4 | 30.6 | | |
| | 20.3 | 31.3 | | |
| | 20.4 | 32.2 | | |
| | | 34.4 | | |

## Table 3b

Measurements (in mm) of fused sheep and goat bones from Afridar

**Section I:** Measurements of fused sheep/goat bones from Afridar

(this section includes bones identified as sheep, bones identified as goat, and bones identified as "sheep/goat")

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 15-26.6 | 26.7-38 | 25.6-38.5 | 21-25.2 | 25.7-30.5 | 19.7-24.2 | 23-33 | 23.6-29.3 | 27-34.6 | 50.5-66.5 |
| **Mean** | **21.1** | **31.7** | **33** | **23.4** | **27.7** | **21.6** | **28.3** | **26.7** | **30.8** | **60.4** |
| Data | 15 | 26.7 | 25.6 | 21 | 25.7 | 19.7 | 23 | 23.6 | 27 | 50.5 |
| | 15.6 | 26.7 | 28.1 | 22 | 25.7 | 21 | 24.3 | 24.5 | 27.2 | 53 |
| | 16.5 | 27 | 30.5 | 23 | 26.1 | 21.6 | 24.4 | 25.4 | 27.3 | 53.8 |
| | 16.9 | 28.3 | 31.5 | 23.6 | 26.5 | 21.6 | 24.6 | 26.2 | 28.5 | 58.7 |
| | 17.2 | 28.7 | 31.7 | 24.3 | 27 | 24.2 | 24.8 | 26.3 | 28.5 | 59.3 |
| | 17.3 | 29 | 32 | 25 | 28.3 | | 25.5 | 27 | 28.8 | 60 |
| | 18.1 | 29 | 32.8 | 25.2 | 28.5 | | 26 | 27.4 | 29 | 60 |
| | 18.5 | 29 | 32.8 | | 28.6 | | 26.3 | 27.5 | 29.1 | 60.8 |
| | 18.6 | 29.2 | 33.4 | | 28.6 | | 26.3 | 29.1 | 29.2 | 61 |
| | 18.8 | 29.5 | 33.7 | | 29.7 | | 26.3 | 29.3 | 29.6 | 61.7 |
| | 19 | 29.6 | 34.8 | | 30.5 | | 26.4 | | 29.7 | 62.3 |
| | 19 | 29.8 | 35 | | | | 26.4 | | 29.7 | 63.2 |
| | 19.1 | 30 | 36.7 | | | | 26.7 | | 29.8 | 64 |
| | 19.2 | 30 | 37.4 | | | | 26.7 | | 30 | 65.7 |
| | 19.3 | 30 | 38.5 | | | | 27 | | 30 | 66 |
| | 19.5 | 30.4 | | | | | 27 | | 30.1 | 66.5 |
| | 19.8 | 30.4 | | | | | 27 | | 30.6 | |
| | 20 | 30.6 | | | | | 27.2 | | 30.6 | |
| | 20 | 30.7 | | | | | 27.3 | | 30.7 | |
| | 20.1 | 30.7 | | | | | 27.6 | | 31 | |
| | 20.3 | 31 | | | | | 27.6 | | 31.3 | |
| | 20.4 | 31 | | | | | 27.7 | | 31.4 | |
| | 20.6 | 31.5 | | | | | 28 | | 31.4 | |
| | 20.7 | 31.6 | | | | | 28 | | 31.4 | |
| | 20.8 | 31.7 | | | | | 28 | | 31.5 | |
| | 20.8 | 31.7 | | | | | 28 | | 31.5 | |
| | 21 | 31.8 | | | | | 28 | | 31.6 | |
| | 21 | 32.2 | | | | | 28 | | 31.8 | |
| | 21 | 32.3 | | | | | 28 | | 32.5 | |
| | 21 | 32.4 | | | | | 28.2 | | 33.3 | |
| | 21.2 | 32.5 | | | | | 28.2 | | 34 | |
| | 21.3 | 32.6 | | | | | 28.2 | | 34.1 | |
| | 21.3 | 32.6 | | | | | 28.2 | | 34.2 | |
| | 21.8 | 32.8 | | | | | 28.3 | | 34.6 | |
| | 21.8 | 33 | | | | | 28.3 | | | |
| | 21.8 | 33 | | | | | 28.3 | | | |
| | 21.8 | 33.3 | | | | | 28.5 | | | |
| | 22 | 33.3 | | | | | 28.6 | | | |
| | 22.3 | 33.3 | | | | | 28.6 | | | |
| | 22.4 | 33.6 | | | | | 28.7 | | | |
| | 22.4 | 33.8 | | | | | 28.8 | | | |
| | 22.5 | 34 | | | | | 28.8 | | | |
| | 22.5 | 34.2 | | | | | 28.9 | | | |
| | 22.6 | 34.3 | | | | | 29 | | | |
| | 22.7 | 34.4 | | | | | 29 | | | |
| | 23 | 34.5 | | | | | 29 | | | |
| | 23 | 34.7 | | | | | 29.1 | | | |
| | 23 | 35.3 | | | | | 29.2 | | | |
| | 23 | 35.5 | | | | | 29.3 | | | |
| | 23.2 | 35.5 | | | | | 29.5 | | | |
| | 23.2 | 38 | | | | | 29.6 | | | |
| | 23.3 | | | | | | 29.7 | | | |
| | 23.4 | | | | | | 29.8 | | | |
| | 24 | | | | | | 29.8 | | | |
| | 24.4 | | | | | | 30 | | | |
| | 24.4 | | | | | | 30 | | | |
| | 25 | | | | | | 30.1 | | | |
| | 25.8 | | | | | | 30.4 | | | |
| | 26.1 | | | | | | 30.5 | | | |
| | 26.6 | | | | | | 30.5 | | | |
| | | | | | | | 30.9 | | | |
| | | | | | | | 31 | | | |
| | | | | | | | 31.6 | | | |
| | | | | | | | 31.7 | | | |
| | | | | | | | 32.1 | | | |
| | | | | | | | 33 | | | |

Table 3b (cont.)

**Section II:** Measurements of fused **sheep** bones from Afridar
(these bones are also included in Section I)

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 21.8-22 | 28.3-38 | 31.5- | 25 | 25.7-30.5 | NA | 27-29.7 | 23.6-29.3 | 27.2-34 | 53 |
| **Mean** | **21.9** | **32.4** | **34.7** | **25** | **27.7** | **NA** | **28** | **26.8** | **30.4** | **53** |
| Data | 21.8 | 28.3 | 31.5 | 25 | 25.7 | | 27 | 23.6 | 27.2 | 53 |
| | 22 | 29 | 31.7 | | 25.7 | | 27.3 | 24.5 | 28.5 | |
| | | 29.6 | 33.4 | | 26.1 | | 29.7 | 26.2 | 28.5 | |
| | | 30.7 | 33.7 | | 26.5 | | | 26.3 | 29.2 | |
| | | 31 | 34.8 | | 28.3 | | | 27 | 30.6 | |
| | | 31 | 35 | | 28.5 | | | 27.4 | 31.4 | |
| | | 31.7 | 36.7 | | 28.6 | | | 27.5 | 31.5 | |
| | | 31.7 | 37.4 | | 29.7 | | | 29.1 | 32.5 | |
| | | 32.6 | 38.5 | | 30.5 | | | 29.3 | 34 | |
| | | 33 | | | | | | | | |
| | | 33 | | | | | | | | |
| | | 33.3 | | | | | | | | |
| | | 33.3 | | | | | | | | |
| | | 33.6 | | | | | | | | |
| | | 33.8 | | | | | | | | |
| | | 34 | | | | | | | | |
| | | 34.2 | | | | | | | | |
| | | 34.4 | | | | | | | | |
| | | 38 | | | | | | | | |

**Section III:** Measurements of fused **goat** bones from Afridar
(these bones are also included in Section I)

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | NA | 29.2-30 | 32.8 | NA | NA | NA | NA | NA | 27.3-29.8 | NA |
| **Mean** | **NA** | **29.6** | **32.8** | **NA** | **NA** | **NA** | **NA** | **NA** | **28.6** | **NA** |
| Data | | 29.2 | 32.8 | | | | | | 27.3 | |
| | | 30 | | | | | | | 28.8 | |
| | | | | | | | | | 29.8 | |

## Table 3c

Measurements (in mm) of fused sheep and goat bones from the Halif Terrace

**Section I:** Measurements of fused sheep/goat bones from the Halif Terrace
(this section includes bones identified as sheep, bones identified as goat, and bones identified as "sheep/goat")

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 21.2-23.7 | 26.9-36.9 | 29.5 | | 24.4-29.5 | | 26.2-31.3 | 22.8-27.6 | 26.9-33.7 | 49.1-66.9 |
| **Mean** | **22.3** | **31.6** | **29.5** | | **26.7** | | **28.8** | **25.9** | **29.2** | **58.7** |
| Data | 21.2 | 26.9 | 29.5 | | 24.4 | | 26.2 | 22.8 | 26.9 | 49.1 |
| | 21.9 | 27.6 | | | 25.8 | | 31.3 | 24.4 | 27.3 | 53.4 |
| | 23.7 | 28.1 | | | 26.1 | | | 24.9 | 27.5 | 54.8 |
| | | 29.2 | | | 26.8 | | | 26.4 | 27.9 | 55.2 |
| | | 29.3 | | | 26.8 | | | 26.5 | 28.6 | 55.2 |
| | | 29.5 | | | 27.2 | | | 26.8 | 28.7 | 58.0 |
| | | 30.2 | | | 27.3 | | | 26.9 | 28.8 | 58.8 |
| | | 30.6 | | | 29.5 | | | 27.1 | 29.2 | 58.8 |
| | | 30.7 | | | | | | 27.6 | 29.2 | 61.3 |
| | | 31.1 | | | | | | | 29.6 | 61.8 |
| | | 31.2 | | | | | | | 29.8 | 64.3 |
| | | 31.6 | | | | | | | 30.1 | 65.8 |
| | | 31.6 | | | | | | | 30.6 | 66.9 |
| | | 31.9 | | | | | | | 31.7 | |
| | | 32.5 | | | | | | | 32.2 | |
| | | 32.5 | | | | | | | 32.7 | |
| | | 32.7 | | | | | | | 32.8 | |
| | | 33.1 | | | | | | | 33.3 | |
| | | 33.2 | | | | | | | 33.7 | |
| | | 33.7 | | | | | | | | |
| | | 34.2 | | | | | | | | |
| | | 35.5 | | | | | | | | |
| | | 36.4 | | | | | | | | |
| | | 36.8 | | | | | | | | |
| | | 36.9 | | | | | | | | |

**Section II:** Measurements of fused **sheep** bones from the Halif Terrace
(these bones are also included in Section I)

| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
|---|---|---|---|---|---|---|---|---|---|---|
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 21.2-21.9 | 26.9-36.8 | NA | NA | 25.8-29.5 | NA | NA | 22.8-27.6 | 26.9-33.7 | NA |
| **Mean** | **21.6** | **31.2** | **NA** | **NA** | **27.2** | **NA** | **NA** | **25.8** | **30.5** | **NA** |
| Data | 21.2 | 26.9 | | | 25.8 | | | 22.8 | 26.9 | |
| | 21.9 | 27.6 | | | 26.8 | | | 24.4 | 27.5 | |
| | | 29.2 | | | 26.8 | | | 24.9 | 27.9 | |
| | | 29.3 | | | 27.2 | | | 26.4 | 28.6 | |
| | | 29.5 | | | 29.5 | | | 26.5 | 29.6 | |
| | | 30.2 | | | | | | 26.9 | 30.1 | |
| | | 30.7 | | | | | | 27.1 | 30.6 | |
| | | 31.6 | | | | | | 27.6 | 32.2 | |
| | | 31.9 | | | | | | | 32.7 | |
| | | 32.5 | | | | | | | 32.8 | |
| | | 32.5 | | | | | | | 33.3 | |
| | | 33.7 | | | | | | | 33.7 | |
| | | 34.2 | | | | | | | | |
| | | 36.8 | | | | | | | | |

Table 3c (cont.)

| **Section III:** Measurements of fused **goat** bones from the Halif Terrace (these bones are also included in Section I) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bone** | **scapula** | **humerus** | **radius** | **ulna** | **metacarpal** | **femur** | **tibia** | **metatarsal** | **astragalus** | **calcaneus** |
| Measurement | SLC | BT | Bd | SDO | Bd | DC | Bd | Bd | GLl | GL |
| Range | 23.7 | 30.6-36.4 | NA | NA | 24.4-27.3 | NA | NA | NA | 27.3-29.8 | NA |
| **Mean** | **23.7** | **33.2** | **NA** | **NA** | **25.9** | **NA** | **NA** | **NA** | **28.6** | **NA** |
| Data | 23.7 | 30.6 | | | 24.4 | | | | 27.3 | |
| | | 32.7 | | | 27.3 | | | | 28.8 | |
| | | 33.1 | | | | | | | 29.8 | |
| | | 33.2 | | | | | | | | |
| | | 36.4 | | | | | | | | |

## Table 4a

Measurements (in mm) of fused cattle bones at Shiqmim

| **Bone** | **scapula** | **ulna** | **metacarpal** | **femur** | **tibia** | **calcaneus** | **metatarsal** | **phalanx 1** | **phalanx 2** |
|---|---|---|---|---|---|---|---|---|---|
| Measurement | GLP | SDO | Bd | DC | Bd | GL | Bd | Glpe | Glpe |
| Range | 44.2-61.4 | 40.8 | 62.2 | 36 | 53.7 | 99.5 | | 52.2-56.2 | 35.8-37.8 |
| **Mean** | **52.8** | **40.8** | **62.2** | **36** | **53.7** | **99.5** | | **53.7** | **36.5** |
| Data | 44.2 | 40.8 | 62.2 | 36 | 53.7 | 99.5 | | 52.2 | 35.8 |
| | 61.4 | | | 36 | | | | 52.4 | 36 |
| | | | | | | | | 53.7 | 36.5 |
| | | | | | | | | 54 | 37.8 |
| | | | | | | | | 56.2 | |

# Table 4b

## Measurements (in mm) of fused cattle bones at Afridar Area G

Note: Measurements in *italics* with a superscript "*w*" are taken on bones identified as coming from wild cattle, *Bos primigenius*

| **Bone** | **scapula** | **ulna** | **metacarpal** | **femur** | **tibia** | **calcaneus** | **metatarsal** | **phalanx 1** | **phalanx 2** |
|---|---|---|---|---|---|---|---|---|---|
| Measurement | GLP | SDO | Bd | DC | Bd | GL | Bd | Glpe | Glpe |
| Range | 59.4-81 | 69.5 | 59.3-75 | 33-50 | 62-76.5 | 114-163.7 | 56-68.2 | 57-75 | 39.7-52 |
| **Mean** | **67.7** | **69.5** | **68.8** | **45.0** | **68.5** | **139.6** | **63.6** | **66.1** | **45.8** |
| Data | 59.4 | 69.5 | 59.3 | 33 | 62 | 114 | 56 | 57 | 39.7 |
| | 62 | | 72 | 45 | 64.8 | 131 | 61.2 | 57.4 | 39.7 |
| | 68.4 | | 75 | 45.6 | 67.2 | 137 | 63.3 | 59 | 40 |
| | 81 | | | 46.7 | 68 | 139 | 66.5 | 59.3 | 40.4 |
| | | | | 47 | 68.6 | 145 | 66.5 | 60.7 | 41.4 |
| | | | | 47.4 | 68.6 | 147.5 | 68.2 | 61 | 42 |
| | | | | 50 | 69 | *163.7*$^{w}$ | | 61 | 42 |
| | | | | | 69.2 | | | 61.8 | 42 |
| | | | | | 71 | | | 62 | 42.4 |
| | | | | | 76.5 | | | 62.7 | 42.7 |
| | | | | | | | | 62.8 | 43 |
| | | | | | | | | 63 | 43 |
| | | | | | | | | 63 | 43 |
| | | | | | | | | 63 | 43.2 |
| | | | | | | | | 63 | 44.2 |
| | | | | | | | | 63 | 44.4 |
| | | | | | | | | 63.2 | 44.4 |
| | | | | | | | | 63.2 | 45 |
| | | | | | | | | 63.5 | 45 |
| | | | | | | | | 63.7 | 45 |
| | | | | | | | | 63.8 | 45 |
| | | | | | | | | 64.1 | 46 |
| | | | | | | | | 64.5 | 46 |
| | | | | | | | | 65 | 46.2 |
| | | | | | | | | 65 | 46.6 |
| | | | | | | | | 65 | 46.7 |
| | | | | | | | | 65 | 47.4 |
| | | | | | | | | 65.1 | 47.5 |
| | | | | | | | | 65.4 | 47.6 |
| | | | | | | | | 65.5 | 48 |
| | | | | | | | | 65.7 | 48 |
| | | | | | | | | 65.7 | 48.5 |
| | | | | | | | | 66 | 48.6 |
| | | | | | | | | 66.1 | 48.6 |
| | | | | | | | | 66.7 | 48.8 |
| | | | | | | | | 67.2 | 48.8 |
| | | | | | | | | 67.2 | 49 |
| | | | | | | | | 67.6 | 49 |
| | | | | | | | | 68 | 49.3 |
| | | | | | | | | 68.2 | 49.5 |
| | | | | | | | | 68.3 | 50 |
| | | | | | | | | 68.7 | 50.5 |
| | | | | | | | | 69 | 51 |
| | | | | | | | | 69 | 51 |
| | | | | | | | | 69 | 52 |
| | | | | | | | | 69 | |
| | | | | | | | | 69 | |
| | | | | | | | | 69 | |
| | | | | | | | | 69.6 | |
| | | | | | | | | 69.8 | |
| | | | | | | | | 70.3 | |
| | | | | | | | | 71.6 | |
| | | | | | | | | 71.7 | |
| | | | | | | | | 72.3 | |
| | | | | | | | | 72.3 | |
| | | | | | | | | 73 | |
| | | | | | | | | 73.4 | |
| | | | | | | | | 73.7 | |
| | | | | | | | | 74.7 | |
| | | | | | | | | 75 | |

## Table 4c

Measurements (in mm) of fused cattle bones at the Halif Terrace

Note: Measurements in *italics* with a superscript "*w*" are taken on bones identified as coming from wild cattle, *Bos primigenius*

| **Bone** | scapula | ulna | metacarpal | femur | tibia | calcaneus | metatarsal | phalanx 1 | phalanx 2 |
|---|---|---|---|---|---|---|---|---|---|
| Measurement | GLP | SDO | Bd | DC | Bd | GL | Bd | Glpe | Glpe |
| Range | | | 55.2-81.5 | | 53.7-64.5 | 133.8 | 45.1 | 58.2-81.5 | 43.8 |
| **Mean** | | | **67.1** | | **59.1** | **133.8** | **45.1** | **67.7** | **43.8** |
| Data | | | *55.2* | | 53.7 | 133.8$^{w}$ | 45.1 | 58.2 | 43.8 |
| | | | *58.2* | | 64.5 | | | 60.2 | |
| | | | *60.2* | | | | | 64.6 | |
| | | | *66.0* | | | | | 65.1 | |
| | | | *67.7*$^{w}$ | | | | | 65.7 | |
| | | | *80.7*$^{w}$ | | | | | 66 | |
| | | | *81.5*$^{w}$ | | | | | 67.7$^{w}$ | |
| | | | | | | | | 80.7$^{w}$ | |
| | | | | | | | | 81.5$^{w}$ | |

## Table 5

Log differences in cattle bones at Afridar, compared with a wild *Bos primigenius** (individuals identified as wild are indicated with a "w" superscript)

*Measurements on wild *Bos* taken from Grigson (1989:Table 1)

| Element (Measurement) | Halif Terrace cattle bone measurements | *Bos primigenius* standard skeleton | Log10 *Bos primigenius* | Log10 Halif Terrace | Log10 Halif Terrace minus Log10 *Bos primigenius* |
|---|---|---|---|---|---|
| Radius (Bp) | 87 | 100 | 1.939519 | 2 | -0.06 |
| | 98.5 | 100 | 1.993436 | 2 | -0.01 |
| | 76.7 | 100 | 1.884795 | 2 | -0.12 |
| Humerus (Bt) | 82 | 89 | 1.913814 | 1.94939 | -0.04 |
| Metacarpal (Bp) | 55.7 | 74 | 1.745855 | 1.86923 | -0.12 |
| | 60.7 | 74 | 1.783189 | 1.86923 | -0.09 |
| | 67 | 74 | 1.826075 | 1.86923 | -0.04 |
| | 69.4 | 74 | 1.841359 | 1.86923 | -0.03 |
| Metacarpal (Bd) | 59.3 | 73 | 1.773055 | 1.86332 | -0.09 |
| | 72 | 73 | 1.857332 | 1.86332 | -0.01 |
| | 75 | 73 | 1.875061 | 1.86332 | 0.01 |
| Tibia (Bd) | 62 | 78 | 1.792392 | 1.8921 | -0.10 |
| | 64.8 | 78 | 1.811575 | 1.8921 | -0.08 |
| | 67.2 | 78 | 1.827369 | 1.8921 | -0.06 |
| | 68 | 78 | 1.832509 | 1.8921 | -0.06 |
| | 68.6 | 78 | 1.836324 | 1.8921 | -0.06 |
| | 68.6 | 78 | 1.836324 | 1.8921 | -0.06 |
| | 69 | 78 | 1.838849 | 1.8921 | -0.05 |
| | 69.2 | 78 | 1.840106 | 1.8921 | -0.05 |
| | 71 | 78 | 1.851258 | 1.8921 | -0.04 |
| | 76.5 | 78 | 1.883661 | 1.8921 | -0.01 |
| Astragalus (GLl) | 62.3 | 83 | 1.794488 | 1.91908 | -0.12 |
| | 63 | 83 | 1.799341 | 1.91908 | -0.12 |
| | 65.5 | 83 | 1.816241 | 1.91908 | -0.10 |
| | 65.7 | 83 | 1.817565 | 1.91908 | -0.10 |
| | 66 | 83 | 1.819544 | 1.91908 | -0.10 |
| | 67 | 83 | 1.826075 | 1.91908 | -0.09 |
| | 67 | 83 | 1.826075 | 1.91908 | -0.09 |
| | 68.4 | 83 | 1.835056 | 1.91908 | -0.08 |
| | 68.7 | 83 | 1.836957 | 1.91908 | -0.08 |
| | 68.7 | 83 | 1.836957 | 1.91908 | -0.08 |
| | 69.4 | 83 | 1.841359 | 1.91908 | -0.08 |
| | 69.6 | 83 | 1.842609 | 1.91908 | -0.08 |
| | 70.2 | 83 | 1.846337 | 1.91908 | -0.07 |
| | 70.6 | 83 | 1.848805 | 1.91908 | -0.07 |
| | 73.3 | 83 | 1.865104 | 1.91908 | -0.05 |
| | 73.3 | 83 | 1.865104 | 1.91908 | -0.05 |

Table 5 (cont.)

| | | | | | |
|---|---|---|---|---|---|
| | 73.5 | 83 | 1.866287 | 1.91908 | -0.05 |
| | 74.8 | 83 | 1.873902 | 1.91908 | -0.05 |
| | 75.4 | 83 | 1.877371 | 1.91908 | -0.04 |
| | 77 | 83 | 1.886491 | 1.91908 | -0.03 |
| | 77.2 | 83 | 1.887617 | 1.91908 | -0.03 |
| Calcaneus (GL) | 114 | 165 | 2.056905 | 2.21748 | -0.16 |
| | 131 | 165 | 2.117271 | 2.21748 | -0.10 |
| | 137 | 165 | 2.136721 | 2.21748 | -0.08 |
| | 139 | 165 | 2.143015 | 2.21748 | -0.07 |
| | 145 | 165 | 2.161368 | 2.21748 | -0.06 |
| | 147.5 | 165 | 2.168792 | 2.21748 | -0.05 |
| | 163.7[w] | 165 | 2.214049 | 2.21748 | 0.00 |
| Metatarsal (Bp) | 43.3 | 62 | 1.636488 | 1.79239 | -0.16 |
| | 43.7 | 62 | 1.640481 | 1.79239 | -0.15 |
| | 47.4 | 62 | 1.675778 | 1.79239 | -0.12 |
| | 49 | 62 | 1.690196 | 1.79239 | -0.10 |
| | 50.8 | 62 | 1.705864 | 1.79239 | -0.09 |
| | 51 | 62 | 1.70757 | 1.79239 | -0.08 |
| | 51 | 62 | 1.70757 | 1.79239 | -0.08 |
| | 53.7 | 62 | 1.729974 | 1.79239 | -0.06 |
| | 54 | 62 | 1.732394 | 1.79239 | -0.06 |
| | 54.5 | 62 | 1.736397 | 1.79239 | -0.06 |
| | 60.5 | 62 | 1.781755 | 1.79239 | -0.01 |
| | 60.8 | 62 | 1.783904 | 1.79239 | -0.01 |
| | 63 | 62 | 1.799341 | 1.79239 | 0.01 |
| Metatarsal (Bd) | 56 | 68 | 1.748188 | 1.83251 | -0.08 |
| | 61.2 | 68 | 1.786751 | 1.83251 | -0.05 |
| | 63.3 | 68 | 1.801404 | 1.83251 | -0.03 |
| | 66.5 | 68 | 1.822822 | 1.83251 | -0.01 |
| | 66.5 | 68 | 1.822822 | 1.83251 | -0.01 |
| | 68.2 | 68 | 1.833784 | 1.83251 | 0.00 |

## Table 6

Log differences in cattle bones at the Halif Terrace, compared with a wild *Bos primigenius** (individuals identified as wild are indicated with a "w" superscript)

*Measurements on wild *Bos* taken from Grigson (1989:Table 1)

| Element (Measurement) | Halif Terrace cattle bone measurements | *Bos primigenius* standard skeleton | Log10 *Bos primigenius* | Log10 Halif Terrace | Log10 Halif Terrace minus Log10 *Bos primigenius* |
|---|---|---|---|---|---|
| Metacarpal (Bd) | 55.2 | 73 | 1.86 | 1.741939 | -0.12 |
| | 58.2 | 73 | 1.86 | 1.764923 | -0.10 |
| | 60.2 | 73 | 1.86 | 1.779596 | -0.08 |
| | 66 | 73 | 1.86 | 1.819544 | -0.04 |
| | $67.7^{w}$ | 73 | 1.86 | 1.830589 | -0.03 |
| | $80.7^{w}$ | 73 | 1.86 | 1.906874 | 0.05 |
| | $81.5^{w}$ | 73 | 1.86 | 1.911158 | 0.05 |
| Tibia (Bd) | 53.7 | 78 | 1.89 | 1.729974 | -0.16 |
| | 64.5 | 78 | 1.89 | 1.80956 | -0.08 |
| Metatarsal (Bd) | 45.1 | 68 | 1.83 | 1.654177 | -0.18 |
| Calcaneus (GL) | $133.8^{w}$ | 165 | 2.22 | 2.126456 | -0.09 |
| Astragalus (GLl) | 58.8 | 83 | 1.919078 | 1.769377 | -0.15 |
| | 63.2 | 83 | 1.919078 | 1.800717 | -0.12 |
| | 65 | 83 | 1.919078 | 1.812913 | -0.11 |
| Phalanx 1 (GL) | 27.4 | 37 | 1.568202 | 1.437751 | -0.13 |
| | 29.3 | 37 | 1.568202 | 1.466868 | -0.10 |
| | 30.1 | 37 | 1.568202 | 1.478566 | -0.09 |
| | 30.3 | 37 | 1.568202 | 1.481443 | -0.09 |
| | 32.2 | 37 | 1.568202 | 1.507856 | -0.06 |
| | 33.1 | 37 | 1.568202 | 1.519828 | -0.05 |
| | 33.6 | 37 | 1.568202 | 1.526339 | -0.05 |
| | 33.8 | 37 | 1.568202 | 1.528917 | -0.04 |
| | 35.7 | 37 | 1.568202 | 1.552668 | -0.02 |
| | $45.2^{w}$ | 37 | 1.568202 | 1.655138 | 0.09 |
| | $49.8^{w}$ | 37 | 1.568202 | 1.697229 | 0.13 |
| Phalanx 2 (GL) | 29.2 | 35 | 1.544068 | 1.465383 | -0.08 |
| | 31.8 | 35 | 1.544068 | 1.502427 | -0.04 |

## Table 7

Description and location of pathologies on bones and teeth from Shiqmim

| Taxon | Element | Part | Prox Fused? | Dist Fused? | Age | Sex | Description of Pathology |
|---|---|---|---|---|---|---|---|
| bos | metacarpal | distal shaft | | y | | | broadened distal articulation with grooves from rubbing against the proximal phalanx |
| bos | thoracic vert | spine | | | | | exostosis on tip of neural spine |
| goat | humerus | dist shaft | | y | | | impressions on lateral side |
| goat | metatarsal | C | | y | | F | hole on medial side of proximal end |
| goat | phalanx 2 | C | y | | | | exostosis on shaft |
| goat | phalanx 1 | C | | | | | exostosis on distal articulation |
| goat | phalanx 1 | C | n | | | | exostosis on middle of volar side |
| sheep | phalanx 1 | C | y | | | | exostosis on distal articulation |
| sh/g | atlas | caudal | y | | | | hole in caudal articular surface |
| sh/g | mand tooth | M1/2 | | | | | early signs of swollen roots |
| sh/g | mand tooth | M3 | | | F+ | | early signs of swollen roots |
| sh/g | mand tooth | P3-M3 | | | | | gold calculus build-up and early signs of swollen roots |
| sh/g | mand tooth | P3-M3 | | | FG | | swollen roots |
| sh/g | mandible | low P2-M1 | | | | | early signs of swollen roots |
| sh/g | mandible | P3-M3 | | | I | | P3-M3 60.6; swollen roots; calculus build-up |
| sh/g | mandible | M1/2 | | | D+ | | swollen roots |
| sh/g | mandible | P3-M3 | | | G | | swollen roots |
| sh/g | mandible | | | | | | swollen roots |
| sh/g | max tooth | M? frag | | | | | swollen roots |
| sh/g | max tooth | M1/2 | | | | | swollen roots |
| sh/g | max tooth | M1-M2 | | | | | swollen roots |
| sh/g | max tooth | | | | | | swollen roots |
| sh/g | max tooth | P2-M3 | | | | | swollen roots |
| sh/g | max tooth | P2-P3 | | | | | swollen roots on M1 |
| sh/g | max tooth | P2-M3 | | | old | | swollen roots |
| sh/g | max tooth | M1/2 | | | old | | very swollen roots |
| sh/g | phalanx 2 | C | | | | | exostosis on medial side |
| sh/g | phalanx 2 | C | y | | | | exostosis on plantar |
| sh/g | tooth | root | | | | | swollen |

## Table 8

Description and location of pathologies on bones and teeth from Afridar

| Taxon | Element | Part | Prox Fused? | Dist Fused? | Age | Sex | Description of Pathology |
|---|---|---|---|---|---|---|---|
| asinus | mandible | nC | | | | | incisors crooked |
| bos | metacarpal | distal shaft | | y | | | hole on plantar side of the shaft of the lateral condyle (above and left of the foramen) |
| bos | metatarsal | distal shaft | | y | | | deep holes on both palmar and dorsal sides, near fusion area (palmar depressions) |
| bos | phalanx 2 | C | y | | | | entire body is covered in exostoses- except proximal articular surface |
| bos | phalanx 2 | C | y | | | | exostosis throughout |
| bos | phalanx 2 | C | y | | | | light exostosis throughout |
| bos | phalanx 1 | nC | y | | | | exostoses on medial side: holes and outgrowths; proximal medial articular surface is worn away |
| bos | phalanx 1 | C | y | | | | exostosis on medial side |
| bos | phalanx 1 | nC | y | | | | holes in lateral, cranial, along fusion, and in center of distal articular surface,caudal aspect |
| bos | phalanx 1 | nC | y | | | | light exostosis on media side, around upper and frontal edges of condyle |
| bos | phalanx 1 | C | y | | | | slight exostosis on zone 3, just on border with zone 2 (lateral side) |
| bos | tibia | distal shaft | | y | | | large hole near distal articulation- chronic infection around nutrient foramen? |
| cervus/ dama | phalanx 1 | prox shaft | y | | | | heavy exostosis on lateral side of proximal shaft |
| gazelle | mandible | M2-M3 | | | | | light gold metallic luster |
| gazelle | mandible | P2-M3 | | | | | gold calculus on lingual side of P2-M1 and buccal of P4 |
| sh/g | humerus | distal shaft | | y | | | exostoses on lateral and medial sides of trochlea |
| sh/g | mandible | M2 | | | CD | | buccal side of jaw around M1 bulging (M1 missing) |
| sh/g | mandible | M1-M2 | | | E | | calculus on buccal side of both teeth; roots look slightly swollen, but are broken near base |
| sh/g | mandible | dp4-M1 | | | CD | | gold calculus on lingual and buccal sides of dp4, M1 |
| sh/g | mandible | P3-M3 | | | I | | gold calculus on lingual side of P4 |
| sh/g | mandible | P2-M3 and diastema frag | | | G | | gold calculus on lingual sides of teeth |
| sh/g | mandible | P2-M3 | | | G | | gold calculus on lingual and buccal sides of all teeth |
| sh/g | mandible | dp3-M1 | | | D | | gold metallic luster on lingual side of teeth |
| sh/g | mandible | P3-M1 | | | NA | | holes in dentine of cusps of M1 |
| sh/g | mandible | P2-M3 | | | G | | metallic calculus on buccal sides of M2 and M3 |
| sh/g | mandible | P2-M3 | | | G | | P4 crooked; P4 and M1 crowded- cutting into P3, each other, and M2 |
| sh/g | mandible | P3-M3 | | | E | | signs of calculus build-up on lingual side |
| sh/g | mandible | P3-M3 | | | H | | teeth crooked; P2 missing |
| sh/g | mandible | P2-M2 | | | DE | | teeth worn at an angle sloping down from the lingual (highest) to the buccal (lowest) side |
| sh/g | mandible | P4-M1 | | | NA | | P4 is worn unevenly and M1 is broken |
| sh/g | maxilla | P3,P4,M2,M3 | | | | | gold calculus sheen on P3 buccal side |
| sh/g | maxilla | P2-M3 | | | | | gold tartar on buccal sides of P2-M2 |
| sh/g | maxilla | dp4, P3-M1 | | | | | P3 crooked |
| sh/g | maxilla | P2-M3 | | | | | P3 turned 90 degrees sideways: mesial-facing side is now facing buccally |
| sh/g | metacarpal | prox shaft | y | | | | exostosis on lateral plantar side of proximal articulation |
| sh/g | tibia | dist shaft | | y | | | hole in distal articular surface |
| sheep | metacarpal | distal shaft | | y | | | huge hole on medial side of distal shaft, plantar side |
| sheep | phalanx 1 | nC | y | | | | slight exostosis on distal lateral shaft |
| sus | mandible | nC | | | | | left P1 is missing, bone filled-in |
| sus | maxilla | P1-M2 | | | | | P2 and P3 are overlapping |
| sus | metacarpal | mcIV | y | y | | | slight exostosis on distal shaft, along fusion line |
| sus | metatarsal | mtIII | y | | | | exostosis on medial side of proximal articular surface |
| sus | phalanx 1 | nC | y | | | | heavy exostosis on palmar/plantar side of upper shaft |

## Table 9

Description and location of pathologies on bones and teeth from the Halif Terrace*

| Taxon | Element | Part | Prox Fused? | Dist Fused? | Age | Sex | Description of Pathology |
|---|---|---|---|---|---|---|---|
| asinus | phal 2 ant | C | y | | | | NA |
| bos | phal 2 | nC | y | | | | NA |
| caballus | phal 1 | dam | y | | | | deep lig insert dist |
| canis | radius | C | y | y | | | small holes lat shft |
| equid | femur | dam/ex cav | y | y | | | |
| equid | phal 2 | dm | y | | | | deep tendon scars |
| gazelle | horncore | was C | | | | M | hole post 2.5 cm above base |
| sh/g | M up | C | | | | | swollen roots |
| sh/g | M1 M2 M3 low | nC | | | G | | swollen roots |
| sh/g | M2 M3 low | | | | F | | see remarks |
| sh/g | m4 up | C | | | | | swollen roots |
| sh/g | mand | P2-M2 | | | EF | | gold calculus |
| sh/g | mand | P4-M3 | | | I | | swollen roots |
| sh/g | mand | trow | | | F | | calculus |
| sh/g | max | M1-M3 | | | | | swollen roots |
| sh/g | P? up | | | | | | swollen roots |
| sh/g | P2 up | | | | | | swollen root |
| sh/g | P3-M2 low | | | | G | | swollen roots |
| sh/g | phal 2 | C | y | | | | exostosis down one side |
| sh/g | radius | prox frg | y | | | | exostosis lateral epiphysis |

* This table reflects the entire corpus of pathologies from the Halif Terrace; however, full descriptions of the pathologies are not available in all cases (where "see remarks" or "see drawing" is noted in the remarks).

## Table 10

Relative frequencies of common taxa from a sample of Early Bronze Age and Chalcolithic sites in the southern Levant

| **Early Bronze Age Sites** | Reference | Sheep/ Goat | Cattle | Pig | Equid | Dog | Gazelle | Deer | Other | Sample Size |
|---|---|---|---|---|---|---|---|---|---|---|
| Tel Yarmuth | (Davis 1988) | 88.0% | 11% | 0 | NA | 0 | 0.3% | 0.3% | 0.2% | n=1184 |
| Arad | (Lernau 1978) | 87.3% | 7.4% | 0.3% | 1.9% | 1.9% | 1.0% | 0 | 2.0% | n=1820 |
| Tel Dalit | (Horwitz 1996b) | 78.0% | 18% | <1% | 1.0% | <1% | 4.0% | 2.0% | NA | n=1071 |
| Jericho | (Clutton-Brock 1979) | 74.4% | 12% | 1.8% | 3.8% | 0 | 5.4% | 2.0% | 0.6% | n=500 |
| Me'ona | (Horwitz 1996a) | 63.0% | 26% | 3% | 0 | 1.0% | 0 | 4.0% | 3.0% | n=115 |
| Tel Nagila | (Ducos 1968) | 58.4% | 29.3% | 2.5% | 1.2% | 0.8% | 4.6% | 0 | 3.0% | n=484 |
| Tel Kinrot | (Hellwing, 1988/9) | 55.2% | 26.5% | 7.6% | 0.8% | 0.5% | 0 | 0.2% | 8.9% | n=341 |
| Tel Dan | (Wapnish and Hesse 1991) | 48.0% | 33% | 5% | 0 | 0 | 0 | 11.0% | 3.0% | n=192 |
| Tel Erani | Ducos (1968) | 50.4% | 20.1% | 9% | 7.4% | 0.4% | 7.7% | 0.4% | 4.5% | n=787 |
| En Shadud | (Horwitz, 1985) | 29.0% | 22% | 24% | 25.0% | 0 | 0 | 0 | 1.0% | n=97 |
| **Afridar E** | | 30.6% | 19.7% | 15.4% | 20.9% | 1.7% | 2.7% | 0.2% | 8.8% | n=527 |
| **Afridar F** | | 30% | 29% | 15.8% | 14.9% | 1% | 6.3% | 0.6% | 2.4% | n-303 |
| **Afridar G** | | 56.8% | 21.8% | 15.7% | 1.7% | 0.7% | 1.2% | 0.7% | 1.4% | n=3277 |
| **Halif Terrace EB IA** | | 60.9% | 9.9% | 2.8% | 13.2% | 4.6% | 5.5% | 0 | 3.1% | n=325 |
| **Halif Terrace Early EB IB** | | 68.6% | 14.1% | 1% | 8.4% | 1% | 3.1% | 0 | 3.8% | n=191 |
| **Halif Terrace Late EB IB** | | 73.6% | 11.3% | 1.5% | 6.1% | 1.3% | 3.7% | 0 | 2.5% | n=1117 |
| **Chalcolithic Sites** | | | | | | | | | | |
| Metzer | Ducos (1968) | 22.3% | 20.6% | 44.2% | 0.5% | 3.2% | 2.6% | 6.6% | 0 | n=394 |
| Wadi Gazzeh D | Ducos (1968) | 22.6% | 36.9% | 33.8% | 1.6% | 3.1% | 2.0% | 0 | 0 | n=65 |
| Tel Aviv | Ducos (1968) | 24.5% | 61.4% | 10.7% | 0 | 0 | 3.4% | 0 | 0 | n=599 |
| Munhatta | Ducos (1968) | 30.7% | 31.2% | 25.5% | 0.3% | 0.6% | 11.7% | 0 | 0 | n=358 |
| Gat Govrin | Ducos (1968) | 33.0% | 36.2% | 18.1% | 3.8% | 0 | 8.9% | 0 | 0 | n=210 |
| Grar | Grigson (1995b) | 57.9% | 21.5% | 15.2% | 1.1% | 1% | 1.6% | 0 | 1.7% | n=1276 |
| Abu Matar | (Hanbury-Tenison 1986) | 69.0% | 19% | 0 | 3.0% | 6.0% | 0 | 0 | NA | n=971 |
| Bir es-Safadi | Ducos (1968) | 89.9% | 3.7% | 0 | 0 | 0.8% | 5.3% | 0 | 0 | n=513 |
| **Shiqmim** | | 85% | 11.5% | 0 | 0.1% | 0.3% | 1.0% | 0 | 2.0% | n=1558 |

## Table 11
Relative frequencies of taxa at Shiqmim

| | | | |
|---|---|---|---|
| **Domestic animals:** | | | |
| Common name | *Species name* | Number | % |
| sheep/goat | | 1324 | *85%* |
| (sheep) | *(Ovis aries)* | (118) | |
| (goat) | *(Capra hircus)* | (99) | |
| (sheep/goat) | | (1107) | |
| cattle | *Bos taurus* | 180 | *11.5%* |
| horse | *Equus caballus* | 2 | *0.1%* |
| dog | *Canis domesticus* | 4 | *0.3%* |
| **Total domestic animals:** | | **1510** | ***96.9%*** |
| **Wild animals:** | | | |
| Common name | *Species name* | Number | % |
| gazelle | *Gazella* sp. | 12 | *0.8%* |
| cat (domestic?) | *Felis* sp. | 5 | *0.3%* |
| fox | *Vulpes vulpes* | 1 | *<0.1%* |
| hare | *Lepus* sp. | 6 | *0.4%* |
| rodent | Rodentia | 10 | *0.7%* |
| bird | Aves | 9 | *0.6%* |
| fish | Pisces | 2 | *0.1%* |
| frog | Bufo | 3 | *0.2%* |
| **Total wild animals:** | | **48** | ***3.1%*** |
| ***GRAND TOTAL:*** | | ***1558*** | |

**Table 12**
Relative frequencies of taxa at Afridar Areas E, F, and G*

| **Domestic animals:** | | **Area E** | | **Area F** | | **Area G** | |
|---|---|---|---|---|---|---|---|
| Common name | *Species name* | Number | *%* | Number | *%* | Number | *%* |
| sheep/goat | | 161 | *30.6%* | 91 | *30%* | 1862 | *56.8%* |
| (sheep) | *Ovis aries* | (18) | | (9) | | (130) | |
| (goat) | *Capra hircus* | (7) | | (6) | | (32) | |
| (sheep/goat) | | (136) | | (76) | | (1700) | |
| cattle | *Bos taurus* | 104 | *19.7%* | 88 | *29%* | 714 | *21.8%* |
| pig | *Sus scrofa* | 81 | *15.4%* | 48 | *15.8%* | 515 | *15.7%* |
| equid | *Equus* sp. | 110 | *20.9%* | 45 | *14.9%* | 56 | *1.7%* |
| (donkey) | *(E. asinus)* | (105) | | (42) | | (55) | |
| (horse) | *(E. caballus)* | (5) | | (1) | | (1) | |
| (equid) | | – | | (2) | | – | |
| dog | *Canis domesticus* | 9# | *1.7%* | 3 | *1%* | 22 | *0.7%* |
| **Total domestic animals:** | | **465** | ***88%*** | **275** | ***91%*** | **3170** | ***97%*** |
| **Wild animals:** | | | | | | | |
| Common name | *Species name* | Number | *%* | Number | *%* | Number | *%* |
| gazelle | *Gazella* sp. | 14 | *2.7%* | 19 | *6.3%* | 40 | *1.2%* |
| hartebeest | *Alcelaphus buselaphus* | – | – | 3 | *1%* | 5 | *0.2%* |
| wild cow | *Bos primigenius* | – | – | – | – | 1 | *<0.1%* |
| fallow deer | *Dama dama* | – | – | – | – | 14 | *0.4%* |
| red deer | *Cervus elaphus* | – | – | 1 | *0.3%* | 7 | *0.2%* |
| roe deer | *Capreolus capreolus* | 1 | *0.2%* | 1 | *0.3%* | 3 | *0.1%* |
| fallow deer/red deer | *D.dama/C.elaphus* | – | – | – | – | 5 | *0.2%* |
| lion | *Panthera leo* | – | – | – | – | 2 | *0.1%* |
| cat (domestic?) | *Felis* sp. | – | – | – | – | 2 | *0.1%* |
| hyaena | *Hyaena hyaena* | 1 | *0.2%* | – | – | – | – |
| fox | *Vulpes vulpes* | 1 | *0.2%* | – | – | – | – |
| rodent | Rodentia | 2 | *0.4%* | – | – | 1 | *<0.1%* |
| bird | Aves | 1 | *0.2%* | 1 | *0.3%* | 3 | *0.1%* |
| fish | Pisces | 42 | *8%* | 3 | *1%* | 23 | *0.7%* |
| crocodile | *Crocodilius niloticus* | – | – | – | – | 1 | *<0.1%* |
| sea turtle | Chelonia | – | – | – | – | 1 | *<0.1%* |
| **Total wild animals:** | | **62** | ***12%*** | **28** | ***9%*** | **107** | ***3%*** |
| ***GRAND TOTAL:*** | | *527* | | *303* | | *3277* | |

* This table does not include: 1)shells; 2) bones from intrusive loci.
\# This number includes a partial dog burial from area E, which is counted here as one individual

**Table 13**
Relative frequencies of taxa at the Halif Terrace

| **Domestic animals:** | | **EB IA** | | **Early EB IB** | | **Late EB IB** | |
|---|---|---|---|---|---|---|---|
| Common name | *Species name* | Number | % | Number | % | Number | % |
| sheep/goat | | 198 | *60.9%* | 131 | *68.6%* | 821 | *73.6%* |
| (sheep) | *(Ovis aries)* | (24) | | (15) | | (105) | |
| (goat) | *(Capra hircus)* | (14) | | (9) | | (44) | |
| (sheep/goat) | | (160) | | (107) | | (672) | |
| cattle | *Bos taurus* | 32 | *9.9%* | 27 | *14.1%* | 126 | *11.3%* |
| pig | *Sus scrofa* | 9 | *2.8%* | 2 | *1%* | 17 | *1.5%* |
| equid | *Equus* sp. | 43 | *13.2%* | 16 | *8.4%* | 68 | *6.1%* |
| (donkey) | *(E. asinus)* | (5) | | (3) | | (15) | |
| (horse) | *(E. caballus)* | (1) | | – | | (1) | |
| (equid) | | (37) | | (13) | | (52) | |
| dog | *Canis domesticus* | 15[#] | *4.6%* | 2 | *1%* | 14 | *1.3%* |
| **Total domestic animals:** | | **297** | ***91.4%*** | **178** | ***93.2%*** | **1046** | ***93.5%*** |
| **Wild animals:** | | | | | | | |
| Common name | *Species name* | Number | % | Number | % | Number | % |
| gazelle | *Gazella* sp. | 18 | *5.6%* | 6 | *3.1%* | 41 | *3.7%* |
| hartebeest | *Alcelaphus buselaphus* | 1 | *0.3%* | 4 | *2.1%* | 13 | *1.2%* |
| wild cow | *Bos primigenius* | 1 | *0.3%* | 2 | *1.0%* | 11 | *1.0%* |
| wild pig | *Sus scrofa* | – | – | 1 | *0.5%* | 2 | *0.2%* |
| fox | *Vulpes vulpes* | – | – | – | – | 2 | *0.2%* |
| cat (domestic?) | *Felis* sp. | 1 | *0.3%* | – | – | – | – |
| rodent | Rodentia | 5 | *1.5%* | – | – | – | – |
| ostrich | *Struthio camelus* | – | – | – | – | 1 | *0.1%* |
| bird | Aves | 2 | *0.6%* | – | – | 1 | *0.1* |
| **Total wild animals:** | | **28** | ***8.6%*** | **13** | ***6.8%*** | **71** | ***6.5%*** |
| ***GRAND TOTAL:*** | | *325* | | *191* | | *1117* | |

# This number includes four complete or partial dog skeletons, which are counted as four of the fifteen.

## Table 14

Number of complete bones for each taxon (data for Figure 8)

| TAXON | Number of complete bones | Total number of bones | Percentage complete (of total bones per taxon) |
|---|---|---|---|
| **Sheep/Goat** | | | |
| Shiqmim | 182 | 1324 | **14%** |
| Afridar E | 8 | 161 | **5%** |
| Afridar F | 6 | 91 | **7%** |
| Afridar G | 127 | 1862 | **7%** |
| HT EB IA | 28 | 198 | **9%** |
| HT Early EB IB | 12 | 131 | **9%** |
| HT Late EB IB | 102 | 821 | **12%** |
| **Cattle** | | | |
| Shiqmim | 28 | 180 | **16%** |
| Afridar E | 8 | 104 | **8%** |
| Afridar F | 10 | 88 | **11%** |
| Afridar G | 106 | 714 | **15%** |
| HT EB IA | 3 | 32 | **9%** |
| HT Early EB IB | 5 | 27 | **19%** |
| HT Late EB IB | 12 | 126 | **10%** |
| **Pig** | | | |
| Shiqmim | – | – | **–** |
| Afridar E | 10 | 81 | **12%** |
| Afridar F | 4 | 48 | **8%** |
| Afridar G | 41 | 515 | **8%** |
| HT EB IA | 2 | 9 | **22%** |
| HT Early EB IB | 1 | 2 | **50%** |
| HT Late EB IB | 4 | 17 | **24%** |
| **Equid** | | | |
| Shiqmim | 1 | 2 | **50%** |
| Afridar E | 7 | 110 | **6%** |
| Afridar F | 6 | 45 | **13%** |
| Afridar G | 10 | 56 | **18%** |
| HT EB IA | 8 | 43 | **19%** |
| HT Early EB IB | 1 | 16 | **6%** |
| HT Late EB IB | 19 | 68 | **28%** |
| **Dog** | | | |
| Shiqmim | 0 | 4 | **0%** |
| Afridar E | 8 | 28 | **29%** |
| Afridar F | 1 | 3 | **33%** |
| Afridar G | 6 | 22 | **27%** |
| HT EB IA | 9 | 35 | **26%** |
| HT Early EB IB | 1 | 2 | **50%** |
| HT Late EB IB | 3 | 14 | **21%** |

**Table 15**

Cut mark distribution and location on sheep/goat bones at Shiqmim, Afridar, and the Halif Terrace (HT)

| **SHEEP/GOAT Element** | **Shiqmim** | **Afridar** | **HT EB IA** | **HT Early EB IB** | **HT Late EB IB** |
|---|---|---|---|---|---|
| mandible | | | | | |
| horn core | | 3 | | | 2 |
| atlas | 1 | 1 | | | 1 |
| axis | | 2 | | | 2 |
| scapula, body | | 2 | | | |
| scapula, distal | | 2 | | | |
| humerus, proximal | | 1 | | | |
| humerus, shaft | | 1 | | | |
| humerus, distal | 3 | 4 | | | |
| radius/ulna, proximal | 1 | | 1 | | 4 |
| radius/ulna, shaft | | | | | |
| radius/ulna, distal | | 2 | | | |
| carpal | | | | | |
| metacarpal, proximal | | 2 | | | 5 |
| metacarpal, shaft | | 2 | | | |
| metacarpal, distal | | 2 | | | |
| pelvis, cranial | | 1 | | | |
| pelvis, acetabulum | | 1 | | | |
| pelvis, caudal | | | | | 1 |
| femur, proximal | | | | | 1 |
| femur, shaft | | | | | |
| femur, distal | | 2 | | | 1 |
| tibia, proximal | | | | | |
| tibia, shaft | | 2 | | | |
| tibia, distal | | 1 | | 1 | 1 |
| astragalus | 1 | 7 | | | |
| calcaneus | | 2 | | 1 | |
| other tarsal | | 1 | | | |
| metatarsal, proximal | | 1 | | 4 | 6 |
| metatarsal, shaft | | 1 | | | |
| metatarsal, distal | | 1 | 1 | | |
| phalanx 1 | | 1 | 1 | | 1 |
| phalanx 2 | | 1 | | | |
| TOTAL cut marks | 6 | 46 | 3 | 6 | 25 |
| Total bones | 1324 | 2114 | 198 | 131 | 821 |
| **% bones with cut marks** | **0.5%** | **2.2%** | **1.5%** | **4.6%** | **3.0%** |

## Table 16

Cut mark distribution and location on cattle bones at Shiqmim, Afridar, and the Halif Terrace (HT)

| CATTLE Element | Shiqmim | Afridar | HT EB IA | HT Early EB IB | HT Late EB IB |
|---|---|---|---|---|---|
| mandible | | 1 | | | |
| horn core | | | | | |
| atlas | | | | | |
| axis | | | | 1 | |
| scapula, body | | | | | |
| scapula, distal | | | | | |
| humerus, proximal | | | | | |
| humerus, shaft | | 2 | | | |
| humerus, distal | | 1 | | | |
| radius/ulna, proximal | | | | | |
| radius/ulna, shaft | | 1 | | | 3 |
| radius/ulna, distal | | | | 1 | 1 |
| carpal | | | | | |
| metacarpal, proximal | | | | | 1 |
| metacarpal, shaft | | | | | |
| metacarpal, distal | | 1 | | | |
| pelvis, proximal | | | | | |
| pelvis, acetabulum | | | | | 1 |
| pelvis, distal | | | | | |
| femur, proximal | | | | | |
| femur, shaft | | | | | |
| femur, distal | | | | | |
| tibia, proximal | | | | | |
| tibia, shaft | | | | | |
| tibia, distal | | | | | |
| astragalus | 1 | 11 | | | |
| calcaneus | 1 | 2 | | | |
| other tarsal | | 2 | | | |
| metatarsal, proximal | | | | | |
| metatarsal, shaft | | | | | |
| metatarsal, distal | | | | | 1 |
| phalanx 1 | | 1 | | | |
| phalanx 2 | | 3 | | | |
| TOTAL cut marks | 2 | 25 | 0 | 2 | 7 |
| Total bones | 180 | 906 | 32 | 27 | 126 |
| **% bones with cut marks** | **1.1%** | **2.8%** | **0.0%** | **7.4%** | **5.6%** |

**Table 17**
Cut mark distribution and location on equid bones at Shiqmim, Afridar, and the Halif Terrace (HT)

| EQUID Element | Shiqmim | Afridar | HT EB IA | HT Early EB IB | HT Late EB IB |
|---|---|---|---|---|---|
| mandible | | | | | |
| atlas | | | | | |
| axis | | | | | |
| scapula, body | | | | | |
| scapula, distal | | | | | |
| humerus, proximal | | | | | |
| humerus, shaft | | | | | |
| humerus, distal | | | | | |
| radius/ulna, proximal | | | 1 | 1 | |
| radius/ulna, shaft | | | | | |
| radius/ulna, distal | 1 | | 1 | | |
| carpal | | | | | |
| metacarpal, proximal | | 1 | | | 1 |
| metacarpal, shaft | | | | | |
| metacarpal, distal | | | | | 1 |
| pelvis, proximal | | | | | |
| pelvis, acetabulum | | | | | |
| pelvis, distal | | | | | |
| femur, proximal | | 1 | | | |
| femur, shaft | | | | | |
| femur, distal | | | 1 | | |
| tibia, proximal | | | | | |
| tibia, shaft | | | | | |
| tibia, distal | | | | | |
| astragalus | | | | | |
| calcaneus | | | | | |
| other tarsal | | | | | |
| metatarsal, proximal | | | | | |
| metatarsal, shaft | | | | | |
| metatarsal, distal | | 1 | | 1 | |
| phalanx 1 | | | | | |
| phalanx 2 | | | 1 | | |
| TOTAL cut marks | 1 | 3 | 3 | 2 | 2 |
| Total bones | 2 | 211 | 43 | 16 | 68 |
| **% bones with cut marks** | **50.0%** | **1.4%** | **7.0%** | **12.5%** | **2.9%** |

## Table 18

Cut mark distribution and location on dog bones at Shiqmim, Afridar, and the Halif Terrace

| DOG<br>Element | Shiqmim | Afridar | Halif Terrace-<br>All Phases |
|---|---|---|---|
| mandible | | | |
| atlas | | | |
| axis | | | |
| scapula, body | | | |
| scapula, distal | | | |
| humerus, proximal | | | |
| humerus, shaft | | 1 | |
| humerus, distal | 1 | | |
| radius/ulna, proximal | | | |
| radius/ulna, shaft | | | |
| radius/ulna, distal | | | |
| carpal | | | |
| metacarpal, proximal | | | |
| metacarpal, shaft | | | |
| metacarpal, distal | | | |
| pelvis, proximal | | | |
| pelvis, acetabulum | | | |
| pelvis, distal | | | |
| femur, proximal | | | |
| femur, shaft | | | |
| femur, distal | | | |
| tibia, proximal | | | |
| tibia, shaft | | | |
| tibia, distal | | | |
| astragalus | | | |
| calcaneus | | | |
| other tarsal | | | |
| metatarsal, proximal | | | |
| metatarsal, shaft | | | |
| metatarsal, distal | | | |
| phalanx 1 | | | |
| phalanx 2 | | | |
| TOTAL cut marks | 1 | 1 | 0 |
| Total bones | 4 | 36 | 51 |
| **% bones with cut marks** | **25.0%** | **2.8%** | **0.0%** |

## Table 19

Cut mark distribution and location on pig bones at Shiqmim, Afridar, and the Halif Terrace

| PIG Element | Afridar | Halif Terrace- All phases |
|---|---|---|
| mandible | | |
| atlas | | |
| axis | | |
| scapula, body | | |
| scapula, distal | | |
| humerus, proximal | | |
| humerus, shaft | | |
| humerus, distal | 1 | |
| radius/ulna, proximal | | |
| radius/ulna, shaft | | |
| radius/ulna, distal | | |
| carpal | | |
| metacarpal, proximal | | |
| metacarpal, shaft | | |
| metacarpal, distal | | |
| pelvis, proximal | 1 | |
| pelvis, acetabulum | 1 | |
| pelvis, distal | 1 | |
| femur, proximal | | |
| femur, shaft | | |
| femur, distal | | |
| tibia, proximal | | |
| tibia, shaft | | |
| tibia, distal | | |
| astragalus | 2 | |
| calcaneus | | |
| other tarsal | | |
| metatarsal, proximal | | |
| metatarsal, shaft | | |
| metatarsal, distal | | |
| phalanx 1 | | |
| phalanx 2 | | |
| TOTAL cut marks | 6 | 0 |
| Total bones | 644 | 28 |
| **% bones with cut marks** | **0.9%** | **0.0%** |

**Table 20**
Cut mark distribution and location on gazelle bones at Shiqmim, Afridar, and the Halif Terrace

| **GAZELLE Element** | **Shiqmim** | **Afridar** | **Halif Terrace-All phases** |
|---|---|---|---|
| mandible | | | |
| horn core, base | | 2 | 1 |
| atlas | | | |
| axis | | | |
| scapula, body | | | |
| scapula, distal | | | |
| humerus, proximal | | | |
| humerus, shaft | | | |
| humerus, distal | | 1 | |
| radius/ulna, proximal | | | 1 |
| radius/ulna, shaft | | | |
| radius/ulna, distal | | | |
| carpal | | | |
| metacarpal, proximal | | | |
| metacarpal, shaft | | | |
| metacarpal, distal | | 1 | |
| pelvis, proximal | | | |
| pelvis, shaft | | | |
| pelvis, distal | | | |
| femur, proximal | | | |
| femur, shaft | | | |
| femur, distal | | | |
| tibia, proximal | | | |
| tibia, shaft | | | |
| tibia, distal | | | |
| astragalus | | 3 | 1 |
| calcaneus | | | |
| other tarsal | | | |
| metatarsal, proximal | | | |
| metatarsal, shaft | | | |
| metatarsal, distal | | | |
| phalanx 1 | | | |
| phalanx 2 | | | |
| TOTAL cut marks | 0 | 7 | 3 |
| Total bones | 12 | 73 | 65 |
| **% bones with cut marks** | **0.0%** | **9.6%** | **4.6%** |

## Table 21
Details of sheep/goat bones found in articulation

| Head and Upper Limbs | Lower Limbs and Feet |
|---|---|
| **Shiqmim** | |
| cranium-atlas | tarsal-tarsal-metatarsal |
| cranium-atlas-axis-cervical vertebra | tarsal-tarsal-metatarsal |
| axis-cervical vertebra | metacarpal- phalanx 1- phalanx 2 |
| scapula-radius-ulna | metapodial-phalanx 1- phalanx 2 |
| cranium-atlas-axis | phalanx 1-phalanx 2- phalanx 3 |
| atlas-axis | phalanx 1-phalanx 2- phalanx 2 |
| cervical vertebra- cervical vertebra | phalanx 1-phalanx 1-phalanx 2-phalanx 3 |
| thoracic vertebra- thoracic vertebra | phalanx 1-phalanx 1-phalanx 2-phalanx 2 |
| thoracic vertebra- thoracic vertebra | phalanx 1-phalanx 1-phalanx 2 |
| thoracic vertebra- thoracic vertebra | phalanx 1- phalanx 2 |
| thoracic vertebra- thoracic vertebra | phalanx 2-phalanx 2 |
| radius-ulna | phalanx 1-phalanx 1-phalanx 2-phalanx 2-phalanx 3-phalanx 3 |
| radius-ulna | phalanx 1-phalanx 2- phalanx 3 |
| nearly complete fetal skeleton | phalanx 1-phalanx 2-phalanx 3 |
| | phalanx 2-phalanx 2-phalanx 3-phalanx 3 |
| | astragalus-calcaneus |
| | astragalus-calcaneus |
| | carpal-carpal-carpal |
| | carpal-carpal |
| | carpal-carpal |
| | tarsal-tarsal |
| | tarsal-tarsal |
| | phalanx 1- phalanx 1 |
| | phalanx 1- phalanx 1 |
| | phalanx 1- phalanx 2 |
| | phalanx 1-phalanx 1 |
| | phalanx 2-phalanx 2 |
| | phalanx 2-phalanx 2 |
| | phalanx 3- phalanx 3 |
| **Afridar E** | |
| atlas-axis-cervical vertebra | |
| **Afridar G** | |
| cranium-atlas | astragalus-calcaneus |
| atlas-axis | astragalus-calcaneus |
| radius-ulna | astragalus-calcaneus |
| radius-ulna | astragalus-calcaneus |
| | tarsal-tarsal |
| | phalanx 1- phalanx 2 |
| | phalanx 2- phalanx 3 |
| **Halif Terrace EB IA** | |
| radius-ulna | phalanx 1- phalanx 2 |
| **Halif Terrace Early EB IB** | |
| radius-ulna | |
| **Halif Terrace Late EB IB** | |
| | tibia-astragalus-calcaneus |
| | carpal-carpal-metacarpal |
| | metacarpal- phalanx 1 |
| | phalanx 1-phalanx 2-phalanx 2-phalanx 3 |

## Table 22

Details of cattle bones found in articulation

| Head and Upper Limbs | Lower Limbs and Feet |
|---|---|
| **Shiqmim** | |
| lumbar-lumbar-lumbar-sacral | carpal-carpal<br>calc-astrag-tarsal-tarsal<br>phalanx 1- phalanx 1 |
| **Afridar E** | |
| hum-rad-carpal-metacarpal<br>rad-ulna | tib-calc-metatarsal<br>tib-astrag<br>phalanx 1-phalanx 1-phalanx 2-phalanx 2 |
| **Afridar F** | |
| | tib-astrag-tarsal-metatarsal<br>phalanx 1-phalanx 1 |
| **Afridar G** | |
| rad-ulna | astrag-calc<br>tarsal-metatarsal<br>phalanx 1-phalanx 1<br>phalanx 1-phalanx 1<br>phalanx 1-phalanx 1<br>phalanx 1-phalanx 2<br>phalanx 1-phalanx 2-phalanx 3<br>phalanx 2-phalanx 3<br>phalanx 2-phalanx 3<br>phalanx 2-phalanx 3 |
| **Halif Terrace Late EB IB** | |
| hum-rad-ulna-carpal-carpal-carpal | |

## Table 23

Details of equid bones found in articulation

| Head and Upper Limbs | Lower Limbs and Feet |
|---|---|
| **Afridar E** | |
| cervical vert- cervical vert<br>lumbar vert- lumbar vert<br>rad-ulna | tib-calc-metatarsal<br>astrag-tarsal-metatarsal<br>metatarsal-phalanx 1-phalanx 2 |
| **Afridar F** | |
| radius-metacarpal | carpal-carpal<br>metacarpal-phalanx 1 |
| **Afridar G** | |
| femur-patella | calc-astrag-tarsals-metatarsal-phalanx 1-phalanx 2 |
| **Halif Terrace EB IA** | |
| | metacarpal-phalanx 1-phalanx 2<br>tib-astrag-calc<br>phalanx 1-phalanx 2 |
| **Halif Terrace Early EB IB** | |
| | metacarpal-phalanx 1-phalanx 2 |

**Table 24**
Details of pig bones found in articulation

| Head and Upper Limbs | Lower Limbs and Feet |
|---|---|
| **Afridar G** | |
| | metacarpals III-IV-V |

**Table 25**
Details of dog bones found in articulation

| Head and Upper Limbs | Lower Limbs and Feet |
|---|---|
| **Afridar E** | |
| skeleton | |
| **Afridar G** | |
| hum-rad-ulna<br>tibia (pair) tibia-calc | radius-carpal<br>metacarpal-phalanx 1-phalanx 2 |
| **Halif Terrace EB IA** | |
| skeleton<br>skeleton<br>skeleton (incomplete)<br>axis-cervical vert-cervical vert<br>lumbar vert-lumbar-vert | |
| **Halif Terrace Late EB IB** | |
| axis-cervical vert | |

## Table 26

Numbers of fused and unfused sheep/goat and cattle bones from Shiqmim [(bone fusion stages from Silver (1969)]

| **SHEEP/GOAT Fusion Stage** | | fused | unfused |
|---|---|---|---|
| **10 months** | distal humerus, proximal radius, distal scapula | 65 | 19 |
| **13-16 months** | proximal phalanx, middle phalanx | 88 | 38 |
| **1.5-2.25 years** | distal tibia, distal metacarpal, distal metatarsal | 27 | 51 |
| **2.5-3 years** | calcaneus, distal radius, proximal femur | 26 | 64 |
| **3-3.5 years** | proximal humerus, distal femur, proximal tibia | 18 | 40 |
| **TOTAL** | | 224 | 212 |
| **CATTLE Fusion Stage** | | fused | unfused |
| **18 months** | distal humerus, proximal radius, proximal phalanx, middle phalanx | 16 | 3 |
| **2-2.5 years** | distal tibia, distal metacarpal, distal metatarsal | 4 | 3 |
| **3.5-4 years** | calcaneus, proximal femur, distal radius, proximal humerus, distal femur, proximal tibia | 2 | 7 |
| **TOTAL** | | 22 | 13 |

**Table 27**

Numbers of fused and unfused sheep/goat, cattle and pig bones in Afridar Areas E, F, and G [bone fusion stages from Silver (1969)]

| **SHEEP/GOAT Fusion Stage** | | **Area E** fused | unfused | **Area F** fused | unfused | **Area G** fused | unfused |
|---|---|---|---|---|---|---|---|
| **10 months** | distal humerus, proximal radius, distal scapula | 7 | 7 | 8 | 0 | 176 | 17 |
| **13-16 months** | proximal phalanx, middle phalanx | 7 | 0 | 1 | 2 | 91 | 7 |
| **1.5-2.25 years** | distal tibia, distal metacarpal, distal metatarsal | 13 | 5 | 7 | 2 | 103 | 39 |
| **2.5-3 years** | calcaneus, distal radius, proximal femur | 1 | 5 | 0 | 1 | 28 | 62 |
| **3-3.5 years** | proximal humerus, distal femur, proximal tibia | 3 | 2 | 0 | 1 | 10 | 18 |
| **TOTAL** | | 31 | 19 | 16 | 6 | 408 | 143 |
| **CATTLE Fusion Stage** | | **Area E** fused | unfused | **Area F** fused | unfused | **Area G** fused | unfused |
| **10 months** | distal scapula | 2 | 0 | 0 | 0 | 6 | 0 |
| **18 months** | distal humerus, proximal radius, proximal phalanx, middle phalanx | 18 | 0 | 9 | 2 | 139 | 12 |
| **2-2.5 years** | distal tibia, distal metacarpal, distal metatarsal | 7 | 2 | 5 | 4 | 29 | 13 |
| **3.5-4 years** | calcaneus, proximal femur, distal radius, proximal humerus, distal femur, proximal tibia | 4 | 3 | 0 | 1 | 18 | 35 |
| **TOTAL** | | 31 | 5 | 14 | 7 | 192 | 60 |
| **PIG Fusion Stage** | | **Area E** fused | unfused | **Area F** fused | unfused | **Area G** fused | unfused |
| **1 year** | distal scapula, distal humerus, proximal radius, middle phalanx | 11 | 0 | 3 | 0 | 29 | 14 |
| **2-2.5 years** | proximal phalanx, distal tibia, distal metacarpal, distal metatarsal, calcaneus | 5 | 3 | 5 | 0 | 39 | 22 |
| **3.5 years** | proximal humerus, distal radius, proximal ulna, proximal femur, distal femur, proximal tibia | 0 | 5 | 1 | 2 | 7 | 35 |
| **TOTAL** | | 16 | 8 | 9 | 2 | 75 | 71 |

## Table 28

Numbers of fused and unfused sheep/goat, cattle and pig bones from the Halif Terrace [bone fusion stages from Silver (1969)]

| SHEEP/GOAT Fusion Stage | | EB IA fused | EB IA unfused | Early EB IB fused | Early EB IB unfused | Late EB IB fused | Late EB IB unfused |
|---|---|---|---|---|---|---|---|
| **10 months** | distal humerus, proximal radius, distal scapula | 15 | 4 | 16 | 0 | 51 | 11 |
| **13-16 months** | proximal phalanx, middle phalanx | 9 | 2 | 9 | 0 | 58 | 8 |
| **1.5-2.25 years** | distal tibia, distal metacarpal, distal metatarsal | 8 | 8 | 5 | 3 | 36 | 19 |
| **2.5-3 years** | calcaneus, distal radius, proximal femur | 3 | 9 | 0 | 2 | 26 | 15 |
| **3-3.5 years** | proximal humerus, distal femur, proximal tibia | 3 | 1 | 0 | 0 | 6 | 8 |
| **TOTAL** | | 38 | 24 | 30 | 5 | 177 | 61 |

| CATTLE Fusion Stage | | EB IA fused | EB IA unfused | Early EB IB fused | Early EB IB unfused | Late EB IB fused | Late EB IB unfused |
|---|---|---|---|---|---|---|---|
| **10 months** | distal scapula | 0 | 0 | 0 | 0 | 1 | 0 |
| **18 months** | distal humerus, proximal radius, proximal phalanx, middle phalanx | 6 | 0 | 0 | 0 | 17 | 1 |
| **2-2.5 years** | distal tibia, distal metacarpal, distal metatarsal | 0 | 1 | 0 | 1 | 3 | 5 |
| **3.5-4 years** | calcaneus, proximal femur, distal radius, proximal humerus, distal femur, proximal tibia | 0 | 1 | 2 | 0 | 2 | 10 |
| **TOTAL** | | 6 | 2 | 2 | 1 | 23 | 16 |

| PIG Fusion Stage | | EB IA fused | EB IA unfused | Early EB IB fused | Early EB IB unfused | Late EB IB fused | Late EB IB unfused |
|---|---|---|---|---|---|---|---|
| **1 year** | distal scapula, distal humerus, proximal radius, middle phalanx | 1 | 1 | 0 | 0 | 1 | 1 |
| **2-2.5 years** | proximal phalanx, distal tibia, distal metacarpal, distal metatarsal, calcaneus | 2 | 0 | 0 | 1 | 2 | 1 |
| **3.5 years** | proximal humerus, distal radius, proximal ulna, proximal femur, distal femur, proximal tibia | 0 | 0 | 0 | 0 | 0 | 1 |
| **TOTAL** | | 3 | 1 | 0 | 1 | 3 | 3 |

**Table 29**

Frequency of articulating/pairing elements for the primary domesticates at Shiqmim, Afridar, and the Halif Terrace

| SHIQMIM | Species | # of Articulations | Total # of Bones | Ratio |
|---|---|---|---|---|
| | Equid | 1 | 3 | 1 in 3 |
| | Dog | 0 | 4 | 0 |
| | Sheep/Goat | 133 | 1322 | 1 in 9 |
| | Pig | 0 | 0 | NA |
| | Cattle | 19 | 180 | 1 in 9 |
| **AFRIDAR** | **Species** | **# of Articulations** | **Total # of Bones** | **Ratio** |
| | Equid | 40 | 211 | 1 in 5 |
| | Dog | 30 | 56 | 1 in 2 |
| | Sheep/Goat | 18 | 2110 | 1 in 117 |
| | Pig | 5 | 643 | 1 in 129 |
| | Cattle | 29 | 896 | 1 in 31 |
| **HALIF TERRACE (1994 excavations)** | **Species** | **# of Articulations** | **Total # of Bones** | **Ratio** |
| | Equid | 13 | 60 | 1 in 5 |
| | Dog | 20 | 41 | 1 in 2 |
| | Sheep/Goat | 7 | 420 | 1 in 60 |
| | Pig | 1 | 16 | 1 in 16 |
| | Cattle | 5 | 79 | 1 in 16 |

**Table 30**

Sheep/goat herd composition at Shiqmim, Afridar, and the Halif Terrace

| Site | # sheep bones | # goat bones | sheep/goat ratio |
|---|---|---|---|
| **Shiqmim** (Chalcolithic) | 118 | 99 | 1.2:1 |
| **Afridar** (EB IA) | | | |
| Area E | 18 | 7 | 2.6:1 |
| Area F | 9 | 6 | 1.5:1 |
| Area G | 130 | 32 | 4:1 |
| **Halif Terrace** | | | |
| EB IA | 24 | 14 | 1.8:1 |
| Early EB IB | 15 | 9 | 1.7:1 |
| Late EB IB | 104 | 45 | 2.3:1 |

## Table 31a

Combined cortical thickness in Afridar sheep/goat metapodials, separated by sex

| | **Average combined cortical thickness** (in mm) (metacarpals and metatarsals) | **Number of Specimens** |
|---|---|---|
| **Afridar EB IA** | | |
| Female (sheep and goat) | 7.9 | 5 |
| Male (sheep and goat) | 8.8 | 11 |
| Undetermined (sheep and goat) | 7.4 | 10 |

## Table 31b

Combined cortical thickness, separated by bone and species

| | **Metacarpal** | | | **Metatarsal** | | |
|---|---|---|---|---|---|---|
| | **Number** | **Mean (mm)** | **Min-Max (mm)** | **Number** | **Mean (mm)** | **Min-Max (mm)** |
| **Sheep** | | | | | | |
| EBA* | 6 | **6.6** | 6.0-7.0 | 4 | **7** | 6.0-9.0 |
| Afridar | 14 | **7.6** | 5.9-9.4 | 4 | **8.3** | 7.2-10.2 |
| **Goat** | | | | | | |
| EBA* | 4 | **6.4** | 5.0-8.0 | 3 | **6.3** | 6.0-7.0 |
| Afridar | 2 | **7.0** | 5.4-8.5 | 1 | **6.9** | NA |

*Early Bronze Age data from Horwitz and Smith (1991:Table 3, p.37)

## Table 32

Standard parameters of size for wild onager/wild ass (*Equus hemionus/africanus*) from Mureybet (ca. 8000BC) [from Grigson (1993: Table 2)]

[Note: Data in Grigson's Table 2 are taken from Uerpmann (1986)]

| Element | Measurement* | Mean (mm) | SD |
|---|---|---|---|
| scapula | LG | 44 | 1.98 |
| humerus | Bt | 60 | 1.77 |
| radius | Bd | 58 | 1.86 |
| metacarpal | Bp | 40 | 2.21 |
| tibia | Bd | 55 | 1.84 |
| astragalus | GLm | 47 | 2.06 |
| metapodial | Bd | 37 | 1.5 |
| phalanx 1 | Bp | 39 | 1.89 |
| phalanx 2 | Bp | 38 | 1.9 |

* Measurements follow von den Driesch (1976)

## Table 33

Measurements (in mm) and size indices of equid bones from Afridar E, F, and G

| **Afridar Area E** | | | | | |
|---|---|---|---|---|---|
| **Bone** | **Measurement** | **Size Index** | **Cumulative Freq.** | **Cumulative %** | **Species** |
| Mpod Bd | 35.5 | -25.0 | 0 | 0 | donkey |
| Rad Bd | 57 | -13.4 | 1 | 9 | donkey |
| Mc Bp | 38.9 | -12.4 | 2 | 18 | donkey |
| Phal 2 Bp | 37.6 | -5.3 | 3 | 27 | donkey |
| Mc Bp | 45.2 | 58.8 | 4 | 36 | donkey |
| Phal 1 Bp | 43.5 | 59.5 | 5 | 46 | donkey |
| Mc Bp | 45.3 | 60.0 | 6 | 55 | donkey |
| Mpod Bd | 40.9 | 65.0 | 7 | 64 | donkey |
| Astrag GLm | 53 | 72.8 | 8 | 73 | donkey |
| Astrag GLm | 53.7 | 81.3 | 9 | 82 | donkey |
| Tib Bd | 61.4 | 87.0 | 10 | 91 | donkey |
| Astrag GLm | 54.2 | 87.4 | 11 | 100 | donkey |
| **Afridar Area F** | | | | | |
| **Bone** | **Measurement** | **Size Index** | **Cumulative Freq.** | **Cumulative %** | **Species** |
| Mpod Bd | 36.5 | -8.3 | 0 | 0.0 | donkey |
| Phal 1 Bp | 38.7 | -4.0 | 1 | 9.1 | donkey |
| Mpod Bd | 37.1 | 1.7 | 2 | 18.2 | donkey |
| Mc Bp | 41.7 | 19.2 | 3 | 27.3 | donkey |
| Phal 1 Bp | 40.7 | 22.5 | 4 | 36.4 | donkey |
| Phal 1 Bp | 41.1 | 27.8 | 5 | 45.5 | donkey |
| Hum Bt | 62 | 28.2 | 6 | 54.6 | donkey |
| Astrag GLm | 49.5 | 30.3 | 7 | 63.7 | donkey |
| Rad Bd | 60.6 | 34.9 | 8 | 72.8 | donkey |
| Mc Bp | 43.8 | 43.0 | 9 | 81.9 | donkey |
| Phal 2 Bp | 41.9 | 51.3 | 10 | 91.0 | donkey |
| Rad Bd | 66.4 | 112.9 | 11 | 100.1 | horse? |
| **Afridar Area G** | | | | | |
| **Bone** | **Measurement** | **Size Index** | **Cumulative Freq.** | **Cumulative %** | **Species** |
| Astrag GLm | 45 | -24.3 | 0 | 0.0 | donkey |
| Astrag GLm | 46.6 | -4.9 | 1 | 8.3 | donkey |
| Mpod Bd | 38 | 16.7 | 2 | 16.6 | donkey |
| Phal 2 Bp | 39.4 | 18.4 | 3 | 24.9 | donkey |
| Phal 1 Bp | 40.4 | 18.5 | 4 | 33.2 | donkey |
| Rad Bd | 59.5 | 20.2 | 5 | 41.5 | donkey |
| Mpod Bd | 38.3 | 21.7 | 6 | 49.8 | donkey |
| Phal 2 Bp | 39.7 | 22.4 | 7 | 58.1 | donkey |
| Phal 2 Bp | 40 | 26.3 | 8 | 66.4 | donkey |
| Mpod Bd | 39 | 33.3 | 9 | 74.7 | donkey |
| Phal 1 Bp | 41.6 | 34.4 | 10 | 83.0 | donkey |
| Mpod Bd | 40.6 | 60.0 | 11 | 91.3 | donkey |
| Tib Bd | 74.5 | 264.9 | 12 | 99.6 | horse |

**Table 34**

Measurements and size indices of equid bones from Shiqmim and the Halif Terrace

| **Shiqmim** | | | | | |
|---|---|---|---|---|---|
| **Bone** | **Measurement** | **Size Index** | **Cumulative Freq.** | **Cumulative %** | **Species** |
| Rad Bd | 71 | 174.7 | 0 | 0 | horse |
| **Halif Terrace** | | | | | |
| **Bone** | **Measurement** | **Size Index** | **Cumulative Freq.** | **Cumulative %** | **Species** |
| Phal 2 Bp | 34.2 | -50.0 | 0 | 0.0 | donkey |
| Phal 2 Bp | 34.3 | -48.7 | 1 | 4.5 | donkey |
| Phal 1 Bp | 36.2 | -37.0 | 2 | 9.1 | donkey |
| Phal 2 Bp | 35.3 | -35.5 | 3 | 13.6 | donkey |
| Phal 1 Bp | 36.9 | -27.8 | 4 | 18.2 | donkey |
| Phal 1 Bp | 37.2 | -23.8 | 5 | 22.7 | donkey |
| Mpod Bd | 35.8 | -20.0 | 6 | 27.3 | donkey |
| Mc Bp | 40 | 0.0 | 7 | 31.8 | donkey |
| Mpod Bd | 37 | 0.0 | 8 | 36.4 | donkey |
| Phal 2 Bp | 38.2 | 2.6 | 9 | 40.9 | donkey |
| Astrag GLm | 47.3 | 3.6 | 10 | 45.5 | donkey |
| Mc Bp | 42.2 | 24.9 | 11 | 50.0 | donkey |
| Rad Bd | 59.9 | 25.5 | 12 | 54.5 | donkey |
| Astrag GLm | 50 | 36.4 | 13 | 59.1 | donkey |
| Phal 1 Bp | 42.7 | 48.9 | 14 | 63.6 | donkey |
| Mpod Bd | 40.1 | 51.7 | 15 | 68.2 | donkey |
| Phal 2 Bp | 44.7 | 88.2 | 16 | 72.7 | donkey |
| Astrag GLm | 56.3 | 112.9 | 17 | 77.3 | horse? |
| Tib Bd | 65.2 | 138.6 | 18 | 81.8 | horse |
| Astrag GLm | 59.5 | 151.7 | 19 | 86.4 | horse |
| Tib Bd | 66.8 | 160.3 | 20 | 90.9 | horse |
| Tib Bd | 68.4 | 182.1 | 21 | 95.5 | horse |
| Tib Bd | 71.7 | 226.9 | 22 | 100.0 | horse |

## Table 35

Body part representation for the major domesticates at Shiqmim, Afridar, and the Halif Terrace

| SHIQMIM | | | AFRIDAR (G) | | | HALIF TERRACE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | EB IA | | Early EB IB | | Late EB IB | |
| | Number | Percent | | Number | Percent | | Number | Percent | Number | Percent | Number | Percent |
| **Sheep/Goat** | | | **Sheep/Goat** | | | **Sheep/goat** | | | | | | |
| head | 323 | 25% | head | 556 | 28% | head | 75 | 38% | 46 | 35% | 253 | 31% |
| back | 184 | 14% | back | 272 | 14% | back | 14 | 7% | 11 | 9% | 88 | 11% |
| forelimb | 206 | 16% | forelimb | 379 | 19% | forelimb | 32 | 16% | 26 | 20% | 127 | 15% |
| hindlimb | 170 | 13% | hindlimb | 325 | 16% | hindlimb | 21 | 11% | 16 | 12% | 110 | 13% |
| feet | 435 | 33% | feet | 446 | 23% | feet | 55 | 28% | 31 | 24% | 242 | 30% |
| **TOTAL** | 1318 | | **TOTAL** | 1978 | | **TOTAL** | 197 | | 130 | | 820 | |
| **Cattle** | | | **Cattle** | | | **Cattle** | | | | | | |
| head | 53 | 30% | head | 89 | 12% | head | 9 | 36% | 10 | 38% | 39 | 31% |
| back | 23 | 13% | back | 147 | 19% | back | 2 | 8% | 1 | 4% | 13 | 11% |
| forelimb | 23 | 13% | forelimb | 51 | 7% | forelimb | 4 | 16% | 4 | 15% | 16 | 13% |
| hindlimb | 13 | 7% | hindlimb | 105 | 14% | hindlimb | 2 | 8% | 1 | 4% | 15 | 12% |
| feet | 65 | 37% | feet | 363 | 48% | feet | 8 | 32% | 10 | 38% | 41 | 33% |
| **TOTAL** | 177 | | **TOTAL** | 755 | | **TOTAL** | 25 | | 26 | | 124 | |
| | | | **Pig** | | | **Pig** | | | | | | |
| | | | head | 159 | 28% | head | 1 | 11% | 1 | 50% | 6 | 35% |
| | | | back | 92 | 16% | back | 1 | 11% | 0 | 0 | 0 | 0 |
| | | | forelimb | 107 | 19% | forelimb | 2 | 22% | 0 | 0 | 3 | 18% |
| | | | hindlimb | 103 | 18% | hindlimb | 0 | 0 | 0 | 0 | 2 | 12% |
| | | | feet | 107 | 19% | feet | 5 | 56% | 1 | 50% | 6 | 35% |
| | | | **TOTAL** | 568 | | **TOTAL** | 9 | | 2 | | 17 | |
| **Equid** | | | **Equid** | | | **Equid** | | | | | | |
| head | 0 | 0 | head | 16 | 23% | head | 9 | 21% | 3 | 19% | 34 | 51% |
| back | 0 | 0 | back | 13 | 19% | back | 1 | 2% | 1 | 6% | 6 | 9% |
| forelimb | 2 | 100% | forelimb | 6 | 9% | forelimb | 6 | 14% | 3 | 19% | 7 | 10% |
| hindlimb | 0 | 0 | hindlimb | 6 | 9% | hindlimb | 11 | 26% | 0 | 0 | 4 | 6% |
| feet | 0 | 0 | feet | 29 | 41% | feet | 16 | 37% | 9 | 56% | 16 | 24% |
| | 2 | | **TOTAL** | 70 | | **TOTAL** | 43 | | 16 | | 67 | |

## Table 36a
Body part representation at Shiqmim

| Cattle | | | | Sheep/Goat | | | |
|---|---|---|---|---|---|---|---|
| **Element** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Element** | **Raw Data** | ***Divide by:*** | **Adjusted data** |
| **HEAD** | | | | | | | |
| horncore | 0 | *2* | 0.0 | horncore | 19 | *2* | 9.5 |
| cranium | 3 | *14* | 0.2 | cranium | 38 | *14* | 2.7 |
| mandible | 6 | *2* | 3.0 | mandible | 44 | *2* | 22.0 |
| mand tooth | 12 | *20* | 0.6 | mand tooth | 128 | *20* | 6.4 |
| max tooth | 24 | *12* | 2.0 | max tooth | 87 | *12* | 7.3 |
| **BACK** | | | | | | | |
| atlas | 0 | *1* | 0.0 | atlas | 13 | *1* | 13.0 |
| axis | 1 | *1* | 1.0 | axis | 19 | *1* | 19.0 |
| rib | 10 | *13* | 0.8 | rib | 17 | *13* | 1.3 |
| vert/cv | 2 | *5* | 0.4 | vert/cv | 34 | *5* | 6.8 |
| vert/tv | 6 | *13* | 0.5 | vert/tv | 57 | *13* | 4.4 |
| vert/lv | 7 | *6* | 1.2 | vert/lv | 43 | *7* | 6.1 |
| vert/sv | 2 | *5* | 0.4 | vert/sv1 | 1 | *4* | 0.3 |
| vert/cd | 4 | *18* | 0.2 | vert/cd | 8 | *7* | 1.1 |
| **UPPER FORELIMB** | | | | | | | |
| scapula | 8 | *2* | 4.0 | scapula | 52 | *2* | 26.0 |
| humerus | 10 | *2* | 5.0 | humerus | 70 | *2* | 35.0 |
| radius | 4 | *2* | 2.0 | radius | 64 | *2* | 32.0 |
| ulna | 2 | *2* | 1.0 | ulna | 20 | *2* | 10.0 |
| **UPPER HINDLIMB** | | | | | | | |
| innominate | 2 | *2* | 1.0 | innominate | 54 | *2* | 27.0 |
| femur | 7 | *2* | 3.5 | femur | 48 | *2* | 24.0 |
| tibia | 3 | *2* | 1.5 | tibia | 61 | *2* | 30.5 |
| patella | 1 | *2* | 0.5 | patella | 7 | *2* | 3.5 |
| **FEET** | | | | | | | |
| astrag | 5 | *2* | 2.5 | astrag | 27 | *2* | 13.5 |
| calc | 5 | *2* | 2.5 | calc | 39 | *2* | 19.5 |
| carpal/tarsal | 10 | *18* | 0.6 | carpal/tarsal | 37 | *18* | 2.1 |
| mcarpal | 6 | *2* | 3.0 | mcarpal | 48 | *2* | 24.0 |
| mtarsal | 7 | *2* | 3.5 | mtarsal | 43 | *2* | 21.5 |
| phal prox | 14 | *8* | 1.8 | phal prox | 101 | *8* | 12.6 |
| phal mid | 9 | *8* | 1.1 | phal mid | 74 | *8* | 9.3 |
| phal dist | 8 | *8* | 1.0 | phal dist | 37 | *8* | 4.6 |
| **TOTAL** | **178** | | **44.7** | **TOTAL** | **1290** | | **394.9** |

## Table 36b

Body Part Representation at Afridar E

| Cattle | | | | Sheep/Goat | | | Pig | | | Equid | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Element** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** |
| **HEAD** | | | | | | | | | | | | |
| horncore | 2 | *2* | 1.0 | 1 | *2* | 0.5 | 0 | *0* | 0.0 | 0 | *0* | 0.0 |
| cranium | 7 | *14* | 0.5 | 7 | *14* | 0.5 | 21 | *14* | 1.5 | 3 | *14* | 0.2 |
| mandible | 6 | *2* | 3.0 | 18 | *2* | 9.0 | 9 | *2* | 4.5 | 7 | *2* | 3.5 |
| mand tooth | 5 | *20* | 0.3 | 9 | *20* | 0.5 | 3 | *22* | 0.1 | 18 | *20* | 0.9 |
| max tooth | 6 | *12* | 0.5 | 8 | *12* | 0.7 | 3 | *22* | 0.1 | 15 | *20* | 0.8 |
| **BACK** | | | | | | | | | | | | |
| atlas | 1 | *1* | 1.0 | 2 | *1* | 2.0 | 3 | *1* | 3.0 | 0 | *1* | 0.0 |
| axis | 0 | *1* | 0.0 | 2 | *1* | 2.0 | 1 | *1* | 1.0 | 2 | *1* | 2.0 |
| rib | 2 | *13* | 0.2 | 7 | *13* | 0.5 | 1 | *14* | 0.1 | 1 | *18* | 0.1 |
| vert/cv | 7 | *5* | 1.4 | 7 | *5* | 1.4 | 1 | *5* | 0.2 | 2 | *5* | 0.4 |
| vert/tv | 4 | *13* | 0.3 | 2 | *13* | 0.2 | 1 | *14* | 0.1 | 0 | *18* | 0.0 |
| vert/lv | 2 | *6* | 0.3 | 4 | *7* | 0.6 | 1 | *7* | 0.1 | 2 | *6* | 0.3 |
| vert/sv | 0 | *5* | 0.0 | 1 | *4* | 0.3 | 0 | *4* | 0.0 | 0 | *5* | 0.0 |
| vert/cd | 0 | *18* | 0.0 | 0 | *7* | 0.0 | 0 | *20* | 0.0 | 0 | *13* | 0.0 |
| **UPPER FORELIMB** | | | | | | | | | | | | |
| scapula | 2 | *2* | 1.0 | 11 | *2* | 5.5 | 8 | *2* | 4.0 | 1 | *2* | 0.5 |
| humerus | 4 | *2* | 2.0 | 10 | *2* | 5.0 | 1 | *2* | 0.5 | 2 | *2* | 1.0 |
| radius | 5 | *2* | 2.5 | 10 | *2* | 5.0 | 1 | *2* | 0.5 | 4 | *2* | 2.0 |
| ulna | 2 | *2* | 1.0 | 5 | *2* | 2.5 | 2 | *2* | 1.0 | 3 | *2* | 1.5 |
| **UPPER HINDLIMB** | | | | | | | | | | | | |
| innominate | 1 | *2* | 0.5 | 12 | *2* | 6.0 | 3 | *2* | 1.5 | 10 | *2* | 5.0 |
| femur | 0 | *2* | 0.0 | 3 | *2* | 1.5 | 5 | *2* | 2.5 | 4 | *2* | 2.0 |
| tibia | 7 | *2* | 3.5 | 19 | *2* | 9.5 | 2 | *2* | 1.0 | 6 | *2* | 3.0 |
| patella | 0 | *2* | 0.0 | 0 | *2* | 0.0 | 1 | *2* | 0.5 | 0 | *2* | 0.0 |
| **FEET** | | | | | | | | | | | | |
| astrag | 2 | *2* | 1.0 | 5 | *2* | 2.5 | 2 | *2* | 1.0 | 4 | *2* | 2.0 |
| calc | 5 | *2* | 2.5 | 6 | *2* | 3.0 | 3 | *2* | 1.5 | 4 | *2* | 2.0 |
| carpal/tarsal | 5 | *18* | 0.3 | 1 | *18* | 0.1 | 0 | *26* | 0.0 | 2 | *22* | 0.1 |
| mcarpal | 3 | *2* | 1.5 | 7 | *2* | 3.5 | 1 | *8* | 0.1 | 5 | *2* | 2.5 |
| mtarsal | 5 | *2* | 2.5 | 11 | *2* | 5.5 | 5 | *8* | 0.6 | 6 | *2* | 3.0 |
| phal prox | 12 | *8* | 1.5 | 5 | *8* | 0.6 | 2 | *16* | 0.1 | 2 | *4* | 0.5 |
| phal mid | 9 | *8* | 1.1 | 1 | *8* | 0.1 | 1 | *16* | 0.1 | 2 | *4* | 0.5 |
| phal dist | 1 | *8* | 0.1 | 1 | *8* | 0.1 | 0 | *16* | 0.0 | 0 | *4* | 0.0 |
| **TOTAL** | **105** | | **29.5** | **175** | | **68.5** | **81** | | **25.7** | **105** | | **33.8** |

## Table 36c

Body Part Representation at Afridar F

| Cattle | | | | Sheep/Goat | | | Pig | | | Equid | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Element** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** |
| **HEAD** | | | | | | | | | | | | |
| horncore | 3 | *2* | 1.5 | 3 | *2* | 1.5 | 0 | *0* | 0.0 | 0 | *0* | 0.0 |
| cranium | 4 | *14* | 0.3 | 4 | *14* | 0.3 | 7 | *14* | 0.5 | 0 | *14* | 0.0 |
| mandible | 4 | *2* | 2.0 | 15 | *2* | 7.5 | 10 | *2* | 5.0 | 1 | *2* | 0.5 |
| mand tooth | 6 | *20* | 0.3 | 6 | *20* | 0.3 | 2 | *22* | 0.1 | 4 | *20* | 0.2 |
| max tooth | 8 | *12* | 0.7 | 14 | *12* | 1.2 | 1 | *22* | 0.0 | 6 | *20* | 0.3 |
| **BACK** | | | | | | | | | | | | |
| atlas | 0 | *1* | 0.0 | 4 | *1* | 4.0 | 0 | *1* | 0.0 | 0 | *1* | 0.0 |
| axis | 1 | *1* | 1.0 | 3 | *1* | 3.0 | 0 | *1* | 0.0 | 0 | *1* | 0.0 |
| rib | 2 | *13* | 0.2 | 0 | *13* | 0.0 | 0 | *14* | 0.0 | 0 | *18* | 0.0 |
| vert/cv | 3 | *5* | 0.6 | 1 | *5* | 0.2 | 1 | *5* | 0.2 | 0 | *5* | 0.0 |
| vert/tv | 1 | *13* | 0.1 | 1 | *13* | 0.1 | 0 | *14* | 0.0 | 0 | *18* | 0.0 |
| vert/lv | 1 | *6* | 0.2 | 2 | *7* | 0.3 | 2 | *7* | 0.3 | 0 | *6* | 0.0 |
| vert/sv | 0 | *5* | 0.0 | 0 | *4* | 0.0 | 0 | *4* | 0.0 | 0 | *5* | 0.0 |
| vert/cd | 0 | *18* | 0.0 | 0 | *7* | 0.0 | 0 | *20* | 0.0 | 0 | *13* | 0.0 |
| **UPPER FORELIMB** | | | | | | | | | | | | |
| scapula | 1 | *2* | 0.5 | 7 | *2* | 3.5 | 4 | *2* | 2.0 | 0 | *2* | 0.0 |
| humerus | 5 | *2* | 2.5 | 2 | *2* | 1.0 | 1 | *2* | 0.5 | 2 | *2* | 1.0 |
| radius | 4 | *2* | 2.0 | 5 | *2* | 2.5 | 1 | *2* | 0.5 | 5 | *2* | 2.5 |
| ulna | 0 | *2* | 0.0 | 0 | *2* | 0.0 | 1 | *2* | 0.5 | 0 | *2* | 0.0 |
| **UPPER HINDLIMB** | | | | | | | | | | | | |
| innominate | 6 | *2* | 3.0 | 3 | *2* | 1.5 | 6 | *2* | 3.0 | 0 | *2* | 0.0 |
| femur | 4 | *2* | 2.0 | 2 | *2* | 1.0 | 3 | *2* | 1.5 | 0 | *2* | 0.0 |
| tibia | 7 | *2* | 3.5 | 8 | *2* | 4.0 | 1 | *2* | 0.5 | 0 | *2* | 0.0 |
| patella | 0 | *2* | 0.0 | 0 | *2* | 0.0 | 0 | *2* | 0.0 | 0 | *2* | 0.0 |
| **FEET** | | | | | | | | | | | | |
| astrag | 4 | *2* | 2.0 | 1 | *2* | 0.5 | 2 | *2* | 1.0 | 2 | *2* | 1.0 |
| calc | 2 | *2* | 1.0 | 2 | *2* | 1.0 | 0 | *2* | 0.0 | 2 | *2* | 1.0 |
| carpal/tarsal | 8 | *18* | 0.4 | 0 | *18* | 0.0 | 0 | *26* | 0.0 | 2 | *22* | 0.1 |
| mcarpal | 6 | *2* | 3.0 | 6 | *2* | 3.0 | 2 | *8* | 0.3 | 3 | *2* | 1.5 |
| mtarsal | 5 | *2* | 2.5 | 7 | *2* | 3.5 | 0 | *8* | 0.0 | 5 | *2* | 2.5 |
| phal prox | 11 | *8* | 1.4 | 2 | *8* | 0.3 | 0 | *16* | 0.0 | 4 | *4* | 1.0 |
| phal mid | 2 | *8* | 0.3 | 1 | *8* | 0.1 | 1 | *16* | 0.1 | 2 | *4* | 0.5 |
| phal dist | 2 | *8* | 0.3 | 0 | *8* | 0.0 | 0 | *16* | 0.0 | 0 | *4* | 0.0 |
| **TOTAL** | **100** | | **31.1** | **99** | | **40.2** | **45** | | **15.9** | **38** | | **12.1** |

## Table 36d

Body Part Representation at Afridar G

| Cattle | | | | Sheep/Goat | | | Pig | | | Equid | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Element** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** |
| **HEAD** | | | | | | | | | | | | |
| horncore | 3 | *2* | 1.5 | 18 | *2* | 9.0 | 0 | *0* | 0.0 | 0 | *0* | 0.0 |
| cranium | 13 | *14* | 0.9 | 142 | *14* | 10.1 | 84 | *14* | 6.0 | 2 | *14* | 0.1 |
| mandible | 28 | *2* | 14.0 | 262 | *2* | 131.0 | 56 | *2* | 28.0 | 1 | *2* | 0.5 |
| mand tooth | 22 | *20* | 1.1 | 57 | *20* | 2.9 | 10 | *22* | 0.5 | 8 | *20* | 0.4 |
| max tooth | 22 | *12* | 1.8 | 76 | *12* | 6.3 | 8 | *22* | 0.4 | 4 | *20* | 0.2 |
| **BACK** | | | | | | | | | | | | |
| atlas | 2 | *1* | 2.0 | 25 | *1* | 25.0 | 10 | *1* | 10.0 | 0 | *1* | 0.0 |
| axis | 1 | *1* | 1.0 | 15 | *1* | 15.0 | 1 | *1* | 1.0 | 0 | *1* | 0.0 |
| rib | 58 | *13* | 4.5 | 141 | *13* | 10.8 | 10 | *14* | 0.7 | 5 | *18* | 0.3 |
| vert/cv | 29 | *5* | 5.8 | 51 | *5* | 10.2 | 5 | *5* | 1.0 | 2 | *5* | 0.4 |
| vert/tv | 35 | *13* | 2.7 | 58 | *13* | 4.5 | 11 | *14* | 0.8 | 3 | *18* | 0.2 |
| vert/lv | 28 | *6* | 4.7 | 51 | *7* | 7.3 | 6 | *7* | 0.9 | 0 | *6* | 0.0 |
| vert/sv | 3 | *5* | 0.6 | 6 | *4* | 1.5 | 2 | *4* | 0.5 | 3 | *5* | 0.6 |
| vert/cd | 0 | *18* | 0.0 | 0 | *7* | 0.0 | 0 | *20* | 0.0 | 0 | *13* | 0.0 |
| **UPPER FORELIMB** | | | | | | | | | | | | |
| scapula | 12 | *2* | 6.0 | 106 | *2* | 53.0 | 30 | *2* | 15.0 | 0 | *2* | 0.0 |
| humerus | 19 | *2* | 9.5 | 138 | *2* | 69.0 | 42 | *2* | 21.0 | 1 | *2* | 0.5 |
| radius | 13 | *2* | 6.5 | 114 | *2* | 57.0 | 14 | *2* | 7.0 | 5 | *2* | 2.5 |
| ulna | 7 | *2* | 3.5 | 26 | *2* | 13.0 | 22 | *2* | 11.0 | 0 | *2* | 0.0 |
| **UPPER HINDLIMB** | | | | | | | | | | | | |
| innominate | 28 | *2* | 14.0 | 153 | *2* | 76.5 | 39 | *2* | 19.5 | 3 | *2* | 1.5 |
| femur | 31 | *2* | 15.5 | 33 | *2* | 16.5 | 26 | *2* | 13.0 | 1 | *2* | 0.5 |
| tibia | 42 | *2* | 21.0 | 136 | *2* | 68.0 | 37 | *2* | 18.5 | 1 | *2* | 0.5 |
| patella | 4 | *2* | 2.0 | 3 | *2* | 1.5 | 2 | *2* | 1.0 | 1 | *2* | 0.5 |
| **FEET** | | | | | | | | | | | | |
| astrag | 38 | *2* | 19.0 | 47 | *2* | 23.5 | 7 | *2* | 3.5 | 2 | *2* | 1.0 |
| calc | 23 | *2* | 11.5 | 68 | *2* | 34.0 | 8 | *2* | 4.0 | 2 | *2* | 1.0 |
| carpal/tarsal | 40 | *18* | 2.2 | 11 | *18* | 0.6 | 5 | *26* | 0.2 | 5 | *22* | 0.2 |
| mcarpal | 19 | *2* | 9.5 | 119 | *2* | 59.5 | 25 | *8* | 3.1 | 1 | *2* | 0.5 |
| mtarsal | 54 | *2* | 27.0 | 78 | *2* | 39.0 | 19 | *8* | 2.4 | 8 | *2* | 4.0 |
| phal prox | 86 | *8* | 10.8 | 82 | *8* | 10.3 | 28 | *16* | 1.8 | 3 | *4* | 0.8 |
| phal mid | 56 | *8* | 7.0 | 25 | *8* | 3.1 | 4 | *16* | 0.3 | 4 | *4* | 1.0 |
| phal dist | 41 | *8* | 5.1 | 9 | *8* | 1.1 | 8 | *16* | 0.5 | 3 | *4* | 0.8 |
| **TOTAL** | **757** | | **210.7** | **2050** | | **759.2** | **519** | | **171.4** | **68** | | **17.9** |

## Table 36e

Body Part Representation at the Halif Terrace

| Cattle | | | | Sheep/Goat | | | Pig | | | Equid | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Element** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** | **Raw Data** | ***Divide by:*** | **Adjusted data** |
| **HEAD** | | | | | | | | | | | | |
| horncore | 7 | *2* | 3.5 | 20 | *2* | 10.0 | 0 | *0* | 0.0 | 0 | *0* | 0.0 |
| cranium | 15 | *14* | 1.1 | 56 | *14* | 4.0 | 2 | *14* | 0.1 | 10 | *14* | 0.7 |
| mandible | 12 | *2* | 6.0 | 137 | *2* | 68.5 | 4 | *2* | 2.0 | 6 | *2* | 3.0 |
| mand tooth | 23 | *20* | 1.2 | 128 | *20* | 6.4 | 0 | *22* | 0.0 | 18 | *20* | 0.9 |
| max tooth | 22 | *12* | 1.8 | 174 | *12* | 14.5 | 2 | *22* | 0.1 | 25 | *20* | 1.3 |
| **BACK** | | | | | | | | | | | | |
| atlas | 0 | *1* | 0.0 | 15 | *1* | 15.0 | 0 | *1* | 0.0 | 0 | *1* | 0.0 |
| axis | 3 | *1* | 3.0 | 18 | *1* | 18.0 | 0 | *1* | 0.0 | 0 | *1* | 0.0 |
| rib | 6 | *13* | 0.5 | 24 | *13* | 1.8 | 0 | *14* | 0.0 | 1 | *18* | 0.1 |
| vert/cv | 4 | *5* | 0.8 | 35 | *5* | 7.0 | 1 | *5* | 0.2 | 5 | *5* | 1.0 |
| vert/tv | 8 | *13* | 0.6 | 43 | *13* | 3.3 | 0 | *14* | 0.0 | 0 | *18* | 0.0 |
| vert/lv | 0 | *6* | 0.0 | 22 | *7* | 3.1 | 0 | *7* | 0.0 | 3 | *6* | 0.5 |
| vert/sv | 0 | *5* | 0.0 | 1 | *4* | 0.3 | 0 | *4* | 0.0 | 0 | *5* | 0.0 |
| vert/cd | 0 | *18* | 0.0 | 3 | *7* | 0.4 | 0 | *20* | 0.0 | 0 | *13* | 0.0 |
| **UPPER FORELIMB** | | | | | | | | | | | | |
| scapula | 9 | *2* | 4.5 | 78 | *2* | 39.0 | 0 | *2* | 0.0 | 5 | *2* | 2.5 |
| humerus | 11 | *2* | 5.5 | 77 | *2* | 38.5 | 5 | *2* | 2.5 | 5 | *2* | 2.5 |
| radius | 13 | *2* | 6.5 | 77 | *2* | 38.5 | 2 | *2* | 1.0 | 9 | *2* | 4.5 |
| ulna | 3 | *2* | 1.5 | 27 | *2* | 13.5 | 2 | *2* | 1.0 | 1 | *2* | 0.5 |
| **UPPER HINDLIMB** | | | | | | | | | | | | |
| innominate | 15 | *2* | 7.5 | 105 | *2* | 52.5 | 2 | *2* | 1.0 | 6 | *2* | 3.0 |
| femur | 5 | *2* | 2.5 | 30 | *2* | 15.0 | 0 | *2* | 0.0 | 6 | *2* | 3.0 |
| tibia | 9 | *2* | 4.5 | 66 | *2* | 33.0 | 0 | *2* | 0.0 | 8 | *2* | 4.0 |
| patella | 0 | *2* | 0.0 | 1 | *2* | 0.5 | 0 | *2* | 0.0 | 1 | *2* | 0.5 |
| **FEET** | | | | | | | | | | | | |
| astrag | 9 | *2* | 4.5 | 48 | *2* | 24.0 | 0 | *2* | 0.0 | 7 | *2* | 3.5 |
| calc | 6 | *2* | 3.0 | 43 | *2* | 21.5 | 2 | *2* | 1.0 | 4 | *2* | 2.0 |
| carpal/tarsal | 10 | *18* | 0.6 | 15 | *18* | 0.8 | 0 | *26* | 0.0 | 4 | *22* | 0.2 |
| mcarpal | 7 | *2* | 3.5 | 81 | *2* | 40.5 | 2 | *8* | 0.3 | 5 | *2* | 2.5 |
| mtarsal | 16 | *2* | 8.0 | 74 | *2* | 37.0 | 0 | *8* | 0.0 | 5 | *2* | 2.5 |
| phal prox | 19 | *8* | 2.4 | 86 | *8* | 10.8 | 5 | *16* | 0.3 | 17 | *4* | 4.3 |
| phal mid | 10 | *8* | 1.3 | 50 | *8* | 6.3 | 1 | *16* | 0.1 | 11 | *4* | 2.8 |
| phal dist | 9 | *8* | 1.1 | 12 | *8* | 1.5 | 1 | *16* | 0.1 | 7 | *4* | 1.8 |
| **TOTAL** | **251** | | **75.3** | **1546** | | **525.2** | **31** | | **9.6** | **169** | | **47.4** |

## Appendix A: Sample spreadsheet

| A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|
| Site | Locus | Basket | Stratum | Context | Bone# | NISP | Taxon | Element | Skeletal Area |
| AF | 27 | 215 | 0 | NA | 1 | 1 | bos | astragalus | 5 |
| AF | 27 | 215 | 0 | NA | 2 | 1 | sus | femur | 4 |
| AF | 27 | 215 | 0 | NA | 3 | 1 | sh/g | mandible | 1 |

| K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|
| Part | % Preserved | Side | Prox Fused? | Dist Fused? | Age | Sex | Path | Artic/Pair | Cut/Gnaw | Bnt |
| nC | 4 | L | | | | | | | y | |
| distal shaft | 1 | R | | y/n | | | | | | |
| P3-M3 | 3 | R | | | H | | y | | | |

| V | W | X | Y | Z | AA | AB | AC | AD |
|---|---|---|---|---|---|---|---|---|
| Comments | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 |
| two deep horizontal slices on medial portion of trochlea | 73.5 | 69 | 49.5 | 42 | 36 | | | |
| distal epiphysis recently fused | | | | | 41.3 | | | |
| teeth crooked;P2 missing | | | | | | | | |

## Appendix A2: Description of spreadsheet categories

For all three sites under discussion, the basic unit of analysis is a single bone or bone fragment. This basic unit of analysis is hereafter referred to as a "specimen". Each specimen was subjected to the following criteria, to different levels of success depending on my ability to identify the specimen. Each of the following criterion represents one column in an Excel spreadsheet.

**Column A: Site**

The name of the excavation site. This consists of the abbreviated site name followed by the year in which it was excavated.

| | |
|---|---|
| MM | Afridar, Area E, 1993 excavations (a.k.a. Migdalei Marina) |
| AM | Afridar, Area F, 1993 and 1994 excavations (a.k.a. Ashkelon Marina) |
| AF | Afridar, Area G, 1993 excavations (a.k.a. Ashkelon Afridar) |
| SHQ93 | Shiqmim, 1993 excavations |
| NT94 | Nahal Tillah, 1994 excavations |
| NT95 | Nahal Tillah, 1995 excavations |

**Column B: Locus**

The locus number (larger context number) assigned by the excavators, transcribed directly from the bag or box in which the bones are contained.

**Column C: Basket**

The basket number (smaller context number(s), within each locus) assigned by the excavators, transcribed directly from the bag or box in which the bones are contained.

**Column D: Stratum**

The stratum, or cultural level, from which the bones were recovered.

**Column E: Context**

The archaeological deposit from which the specimen came.

**Column F: Bone #**

Each identified specimen receives a bone number in the catalogue. The bone numbers are listed in the spreadsheet in ascending order, and reflects the order in which the specimens were identified. The assignation of bone numbers is strictly for the purpose of keeping track of the identified bones, both in storage, and within the spreadsheet as it is manipulated during analysis. Each site begins at 1. Since the spreadsheet includes only those bones which were identified at least to family and element, the total number of specimens in the spreadsheet is equal to the NISP (number of identified specimens) for the assemblage. Note: this is not the same as the total number of specimens in the assemblage, which includes all bones, identified and unidentified, and will thus be a much higher number than the NISP.

**Column G: NISP**

This category contains data for quantification. The method used in this study is a combination of NISP and MNI[1], with more emphasis placed on NISP. As described in Chapter 3 (section 3.2.1):

> "The quantification method chosen for this study is a marriage of MNI and NISP, with rather more emphasis placed on NISP. It is based on a method used by Caroline Grigson, and is therefore useful for inter-site comparisons within this study. A "1" in the NISP category of the catalogue refers to one specimen of a particular species (see Appendix B). However, to take into account the possibility that a single animal might be represented by more than one element, bones which were found to obviously pair or articulate with another have been noted with a "0" in the NISP category. This was done so that a rough MNI count can be taken, and any individual with more than one bone which obviously belong to it will not be counted twice. This method was undertaken on a context-specific level; that is, no attempt was made to pair or articulate bones from different loci. This can be seen as a *very* maximal use of MNI quantification."

Below is an example of how the NISP category is used in this study. Bone number 153, a left *Bos* femur is given a "1" because it represents one individual. Bone number 154 is a left bos tibia which is found to articulate with the femur (bone number 153) in the same locus and basket, so the tibia is given an NISP number of "0" to show that it comes from the same individual as bone 153. The fact that the two bones articulate is noted in the column labelled "Artic/Pair." The NISP is, thus, usually "1", but can be "0" if the element can be paired or articulated with another bone in the same locus and basket.

| Site | Loc. | Bask. | Str. | Context | Bone # | NISP | Taxon | Element | Part | Side | Age | Sex | Bnt | Path | Artic/Pair |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MM93 | 14 | 1734 | II | pit | 153 | 1 | bos | femur | dist | L | | | | | 153,154 |
| MM93 | 14 | 1734 | II | pit | 154 | 0 | bos | tibia | prox | L | | | | | 153,154 |

**Column H: Taxon**

In this column, the taxon is noted, either by the genus name or by the animal's common name. The genus names "*Bos*" and "*Sus*" are used for cattle and pig. The expression "sh/g" is used for bones which cannot be distinguished as either sheep or goat, but where the distinction can be made, either "sheep" or "goat" is used. In cases

[1] These methods are described in section 3.2.1.

where it is questionable whether the species is domestic or wild, the species name is given, followed by the abbreviation "sp.", to indicate the species is not known. Examples of this are *Felis* sp., where it is not certain which species of cat was present at that time.

**Column I: Element**

This column is where the name of the element is listed, no matter the size of the fragment.

**Column J: Skeletal Area**

The skeleton is divided into five areas, coded 1 through 5 to facilitate future quantification. The skeletal area is used to assess body part representation in various contexts and taxa. The skeletal areas are as follows:

| Skeletal area code | Area of the skeleton to which it refers | Examples |
|---|---|---|
| 1 | Cranial elements | cranium, mandible, teeth |
| 2 | Axial elements | atlas, axis, vertebra, sternum, sacrum, ribs |
| 3 | Limb elements | scapula, humerus, radius, ulna, pelvis, femur, tibia, fibula |
| 4 | Foot elements | carpals/tarsals, metapodials, phalanges |

**Column K: Part:**

This column is where the specific part of the element present is described.

**Column L: % Preserved**

This is used to describe how much of the complete element is represented by the specimen.

| % preserved code | % of complete element to which it refers | Example |
|---|---|---|
| 5 | 100% present | Complete Tibia |
| 4 | 75% present | All of tibia except the distal epiphysis |
| 3 | 50% present | Proximal end of tibia and half of the shaft |
| 2 | 25% present | Proximal end of tibia, fused to a fragment of the diaphysis |
| 1 | <25% present | The proximal epiphysis, or a fragment of it |

**Column M: Side**

Left or Right side of the body is noted. Where side can not be determined, "NA" for "not available" is entered. When a side is not relevant, such as for an atlas, the "Side" column is left blank.

**Column N: Prox Fused?**

A "y" in this category indicates that the proximal or anterior end of the bone is fused. An "n" in this category indicates that it is unfused. A "y/n" indicates that the proximal or anterior epiphysis is fusing and the fusion line is still clearly visible. If no fusion information is available on the preserved fragment, the category is left blank.

**Column O: Dist Fused?**

A "y" in this category indicates that the distal or posterior end of the bone is fused. An "n" in this category indicates that it is unfused. A "y/n" indicates that the distal or posterior epiphysis is fusing and the fusion line is still clearly visible. If no fusion information is available on the preserved fragment, the category is left blank.

**Column P: Age**

The "Age" category is for notation of age information from teeth. Depending on the taxon in question, different enamel pattern charts are used (Methods for aging based on tooth eruption and wear are discussed in section 3.2.3.2). Whichever is relevant is entered into this category. The tooth is always noted, followed by its wear stage (for example "M3: g").

**Column Q: Sex**

Where distinction is possible, this column notes if a bone or tooth comes from a male or female animal. Otherwise, it is left blank.

**Column R: Path**

The "path" column is for notation and description of any pathologies on the bone or tooth.

**Column S: Artic/Pair**

Any specimens which articulate or pair are noted in this column. This category is linked to the MNI category, and describes why one bone was counted and another was not.

**Column T: Cut/Gnaw**

This category is for notation of any modification on the bone. A "y" in this category indicates that modifications are visible. The type and location of modification would then be described in column V: Comments. Human modifications on bone include chopping, slicing, crushing, and polishing. Animal modifications include gnawing by rodents, and gnawing and ingesting by carnivores.

**Column U: Bnt**

The "Bnt" column is to describe bones with discoloration associated with burning. Color is noted, as well as location.

**Column V: Comments**

Any area which needs further descriptive commentary is detailed here.

**Column W - Column AD: Measurements M1-M8:**

Eight columns are reserved for measurements of specimens, termed M1 through M8. Each element has a body of potential measurements, and these differ by element. For example, Column M2 represents GB in a calcaneum, GLm for an astragalus, and Bp for a tibia. The key to these measurements is therefore extremely important for accurately interpreting Column W through Column AD. It can be found in Appendix B.

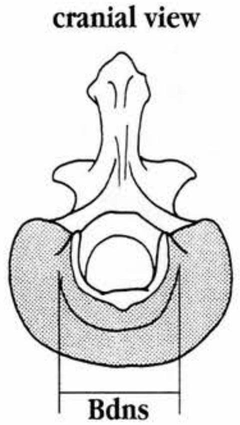
## Appendix B: Key to Measurements

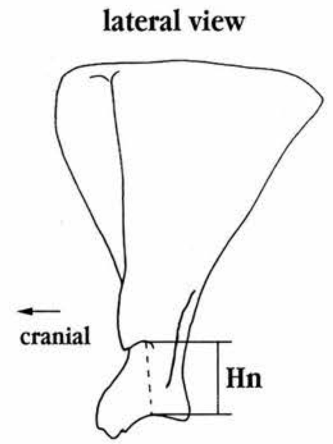
All measurements from von den Driesch [Driesch, 1976 #70], except those marked with * which are additional measurements. Descriptions follow.

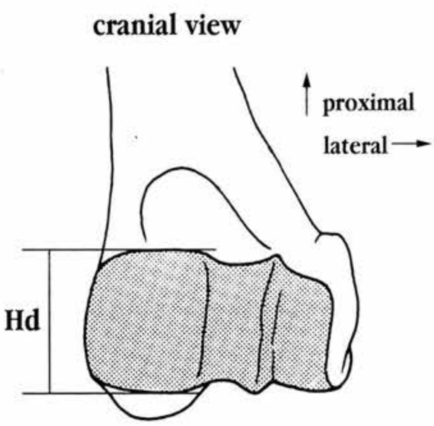
| Element | M-1 | M-2 | M-3 | M-4 | M-5 | M-6 | M-7 | M-8 |
|---|---|---|---|---|---|---|---|---|
| **atlas** | GB | GL | H | BFcr | BFcd | GLF | | |
| **axis** | SBV | BFcr | BFcd | LCDe | LAPa | BPacd | BPtr | Bdns* |
| **vertebrae** | H | BFcr | HFcr | BFcd | HFcd | PL | BPtr | |
| **scapula** | SLC | GLP | LG | BG | HS | DHA | Ld | Hn* |
| **humerus** | GL | SD | Bt | Bd | Bp | Dp | Hd* | |
| **radius** | GL | PL | SD | DD | Bp | BFp | Bd | BFd |
| **ulna** | GL | SDO | DPA | LO | BPC | | | |
| **innominate** | LA | LAR | Sh* | Sb* | Lds* | Dssh* | Hi* | Bi* |
| **sacrum** | GB | BFcr | HFcr | GL | PL | | | |
| **femur** | GL | GLC | Bp | DC | Bd | SD | | |
| **tibia** | GL | Bp | Bd | Dd | SD | | | |
| **carpals/tarsals** | GB | | | | | | | |
| **astragalus** | GLl | GLm | Bd (*Equus*=BFd) | Dl | Dm | | | |
| **calcaneus** | GL | GB | Btu* | Lant* | Dac* | | | |
| **metapodials** | GL | SD | DD | Bp | Dp | Bd | Dlv/Blc/ Dlt* | Dmv/Bmc/ Dmt* |
| **phalanx 1** | Glpe | Bp | Dp | SD | BFp (*Equus*) | Bd | BFd (*Equus*) | |
| **phalanx 2** | GL | Bp | BFp (*Equus*) | Bd | SD | | | |
| **phalanx 3** | HP | Ld | GL (*Equus*) | BF (*Equus*) | GB (*Equus*) | LF (*Equus*) | | |
| **teeth** | GL | GB | crown height, lingual (*Equus*) | crown height, buccal (*Equus*) | | | | |

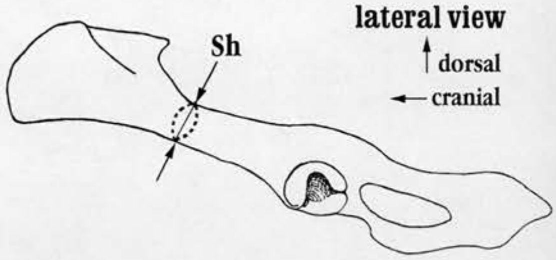
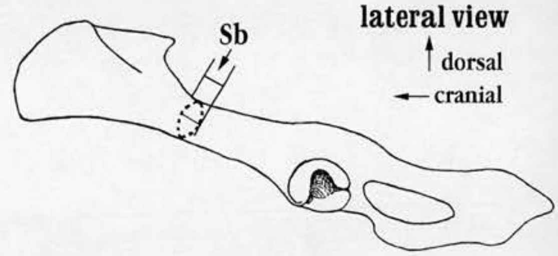
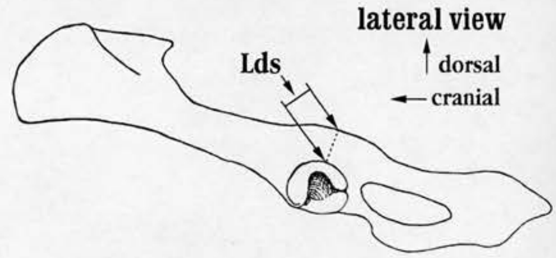
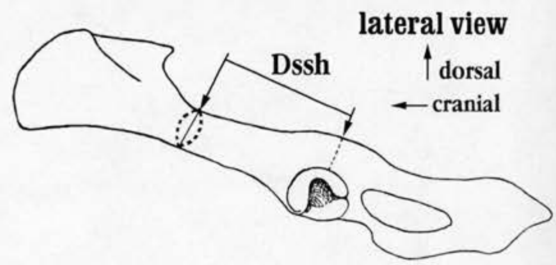
***Additional Measurements:**
Drawings modified from Hillson (1992), Barone (1976), and Schmid (1972).

| Element | Measurement | Description |
|---|---|---|
| axis | Bdns | **B**readth of the **dens**<br><br>Taken across the widest portion of the dens, where it meets the cranial articular process |
| scapula | Hn | **H**eight of the **n**eck<br><br>Taken from the edge of the glenoid cavity to the base of the spine |
| humerus | Hd | **H**eight of the **d**istal articulation<br><br>The greatest height of the distal articulation, taken on the medial side |

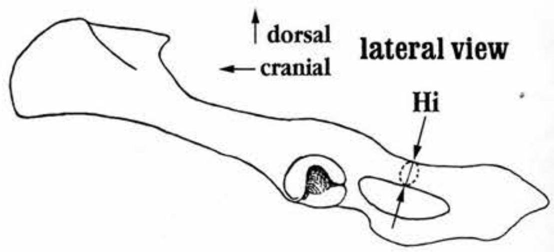
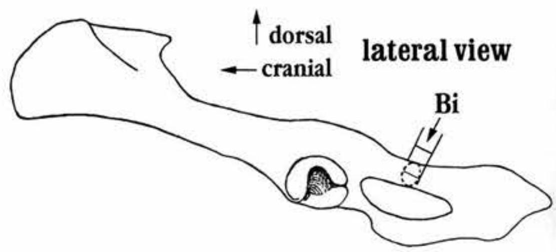
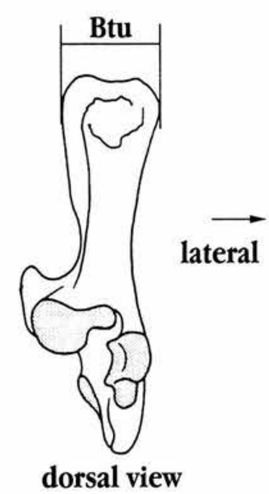


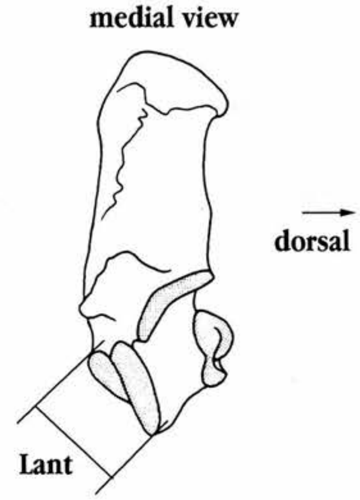



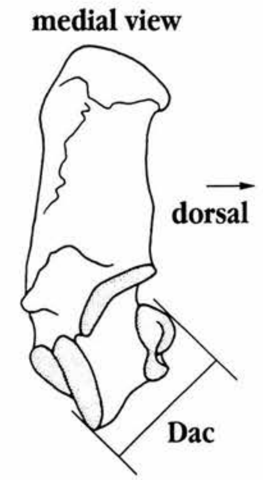
| Element | Measurement | Description | |
|---|---|---|---|
| innominate[#] | Sh | **S**mallest **h**eight of the ilium<br><br>Taken along the narrowest portion of the shaft of the ilium (dorsal-ventral) |  |
| | Sb | **S**mallest **b**readth of the ilium<br><br>Taken along the narrowest portion of the shaft of the ilium (medial-lateral) |  |
| | Lds | **L**ength of the **d**orsal **s**uture of the acetabulum<br><br>The length of the dorsal-facing suture of the acetabulum |  |
| | Dssh | **D**orsal **s**uture of acetabulum to the **s**mallest **h**eight of the ilium<br><br>Distance from the dorsal suture to the point where the SH was measured |  |

[#] The six additional measurements on the innominate were taken only for sheep/goat. Initial results indicate that Dssh x Sh might aide in distinguishing both sheep from goat and male from female. As this technique requires further analysis, preliminary results are not presented in the present study.

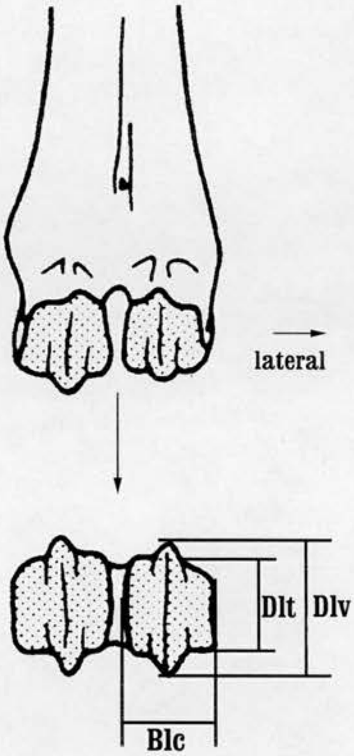
| Element | Measurement | Description | |
|---|---|---|---|
| innominate (cont.) | Hi | Smallest **h**eight of the **i**schium<br><br>Taken along the narrowest portion of the ishium (dorsal-ventral) |  |
| | Bi | Smallest **b**readth of the **i**schium<br><br>Taken along the narrowest portion of the ischium (medial-lateral) |  |
| calcaneus | Btu | **B**readth of the **tu**ber<br><br>The medial-lateral breadth of the tuber calcanei |  |

| | | |
| --- | --- | --- |
| calcaneus (cont.) | Lant | **L**ength of the **ant**erior process<br>Taken along the length of the articular surface of the anterior process |
| | Dac | **D**istance between the **a**nterior process and the **c**oracoid process<br>Taken from the distal tip of the anterior process to the notch of the coracoid process |



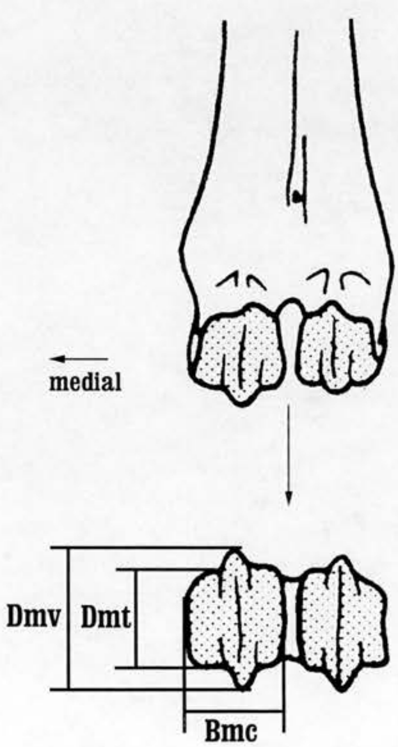



| Element | Measurement | Description |
|---|---|---|
| metapodials | Dlc/Blc/Dlt | **D**epth of the **l**ateral **v**erticillus/ **B**readth of the **l**ateral **c**ondyle/ **D**epth of the **l**ateral **t**rochlear condyle |



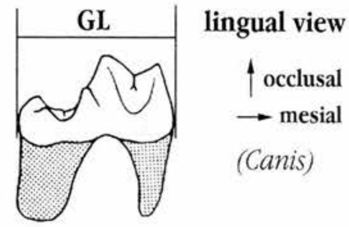

Especially useful for metrical distinction between sheep and goat, after Boessneck (1969) (see section 3.3.1.1)

| | Measurement | Description |
|---|---|---|
| | Dmc/Bmc/Dmt | **D**epth of the **m**edial **v**erticillus/ **B**readth of the **m**edial **c**ondyle/ **D**epth of the **m**edial **t**rochlear condyle |

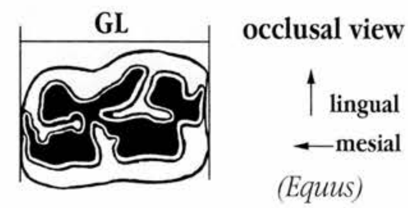



Especially useful for metrical distinction between sheep and goat, after Boessneck (1969) (see section 3.3.1.1)

| Element | Measurement | Description |
|---|---|---|
| teeth | GL | **G**reatest **L**ength |

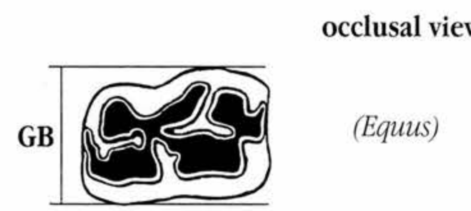



Greatest length of the tooth, measured along the base of the crown in *Sus* and *Canis*, and along the occlusal surface in *Equus*



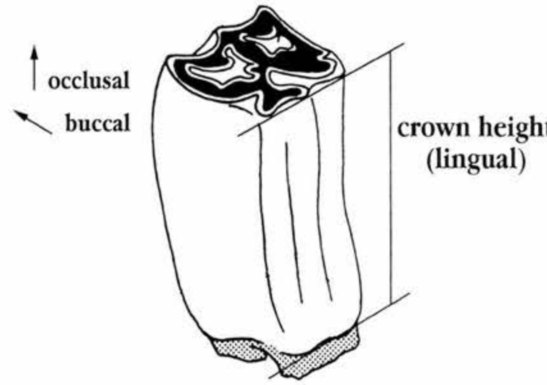

| Element | Measurement | Description |
|---|---|---|
| | GB (*Equus*) | **G**reatest **B**readth |


Greatest breadth of the tooth, measured along the base of the crown in *Sus* and *Canis*, and along the occlusal surface in *Equus*



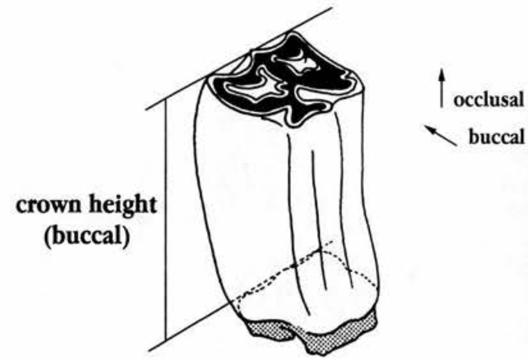

| Element | Measurement | Description |
|---|---|---|
| | Crown height, lingual (*Equus*) | Crown height from the lingual side of the tooth |

Taken on *Equus* premolars and molars, measured from the base of the crown to the occlusal surface on the lingual side of the tooth



| Element | Measurement | Description |
|---|---|---|
| teeth (cont.) | Crown height, buccal (*Equus*) | Crown height from the buccal side of the tooth |

Taken on *Equus* premolars and molars, measured from the base of the crown to the occlusal surface on the buccal side of the tooth

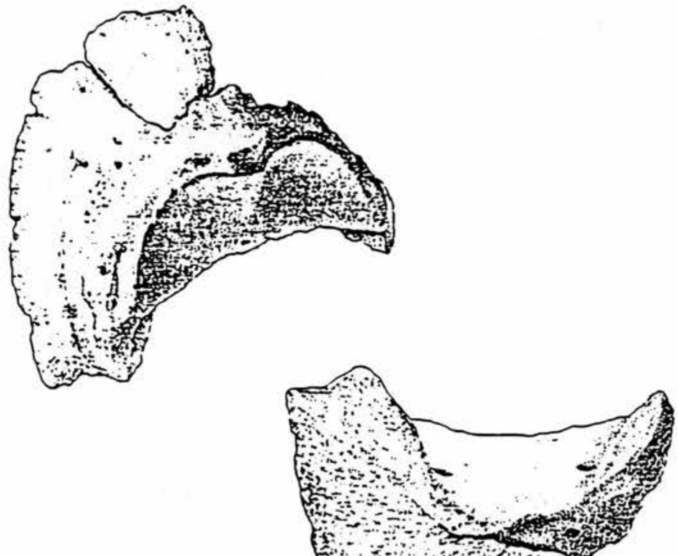


# ARCHAEOZOOLOGY OF THE NEAR EAST III

Proceedings of the third international symposium on the archaeozoology of southwestern Asia and adjacent areas

edited by

**H. Buitenhuis, L. Bartosiewicz and A.M. Choyke**



**ARC - Publicaties 18**
**Groningen, The Netherlands, 1998**

# RECENT FAUNAL ANALYSES AT SHIQMIM, ISRAEL: A PRELIMINARY ANALYSIS ON THE 1993 ASSEMBLAGE

Sarah E. Whitcher[1], Caroline Grigson[2] and Thomas E. Levy[3]

Résumé

Les analyses préliminaires de 1558 ossements d'animaux du site Chalcolithique de Shiqmim dans le nord du desert du Negev en Israel sont presentées plus bas. Trois importants animaux domestiques, mouton, chêvre et bétail, forment la majorité de la faune rassemblée lors des fouilles de 1993. L'importance de l'utilisation de l'animal pour viande, ou pour des produits secondaires tels que lait, laine, toison et pour le travail, est discussé. Les preuves de production artisanal (bobines et bidons) suggerent que ces produits secondaires ont bien été exploités à Shiqmim. L'assemblage de la faune d'une part reflete d'abord l'économie à base de viande de l'animal. Pourtant, il y a peu de signes de produits á usage secondaire, tel que le maintien légèrement plus long du mouton par rapport à la chêvre, et le metapodial d'un bétail avec des blessures probablement dût à l'attelage. La conclusion est que l'exploitation animal à Shiqmim pour temps largement basé sur la viande n'était pas exclusivement basé sur la production de viande, mais probablement impliqué à certaine part aux produits secondaires en usage.

## Introduction

The following paper is based on a poster presentation given at the meeting of the Archaeozoology of Southwest Asia working group (ASWA) of the International Council for Archaeozoology (ICAZ), held in Budapest from September 1-4, 1996. It presents the results of the analysis of the archaeological animal bones from the 1993 excavation season at Shiqmim, a Chalcolithic village in the northern Negev Desert, Israel (Fig. 1). Excavations at Shiqmim were carried out for seven seasons, the first being in 1979 (Levy, 1987).

The excavations at Shiqmim were co-directed by Thomas Levy and David Alon under the auspices of the University of California, San Diego and the Hebrew Union College, Jerusalem. The aim of these excavations focused on examining some of the processes which led to the rise of early social complexity in the northern Negev Desert during the late 5th and early 4th millennium BC (Levy, 1987; 1995). The principal archaeozoologist for Shiqmim is Caroline Grigson, who has published numerous papers presenting various aspects of her work on the Shiqmim faunal material (Grigson 1987a, 1989, 1995). The present study should not be taken to represent the full body of data from the complete excavations at Shiqmim. It is the preliminary analysis of one portion of a much larger body of archaeozoological information which will be presented by Grigson in a comprehensive study of the site of Shiqmim.

## Methodologies

Identification of the bones from the 1993 season at Shiqmim was undertaken by Sarah Whitcher in the archaeozoology laboratory in the Department of Evolution, Systematics and Ecology at the Hebrew University of Jerusalem under the general supervision of Caroline Grigson. As the bones could not be taken out of the country, analysis was limited to five weeks during the summer of 1995. Laboratory analyses focused on the basic variables of archaeozoological identification, with any unusual

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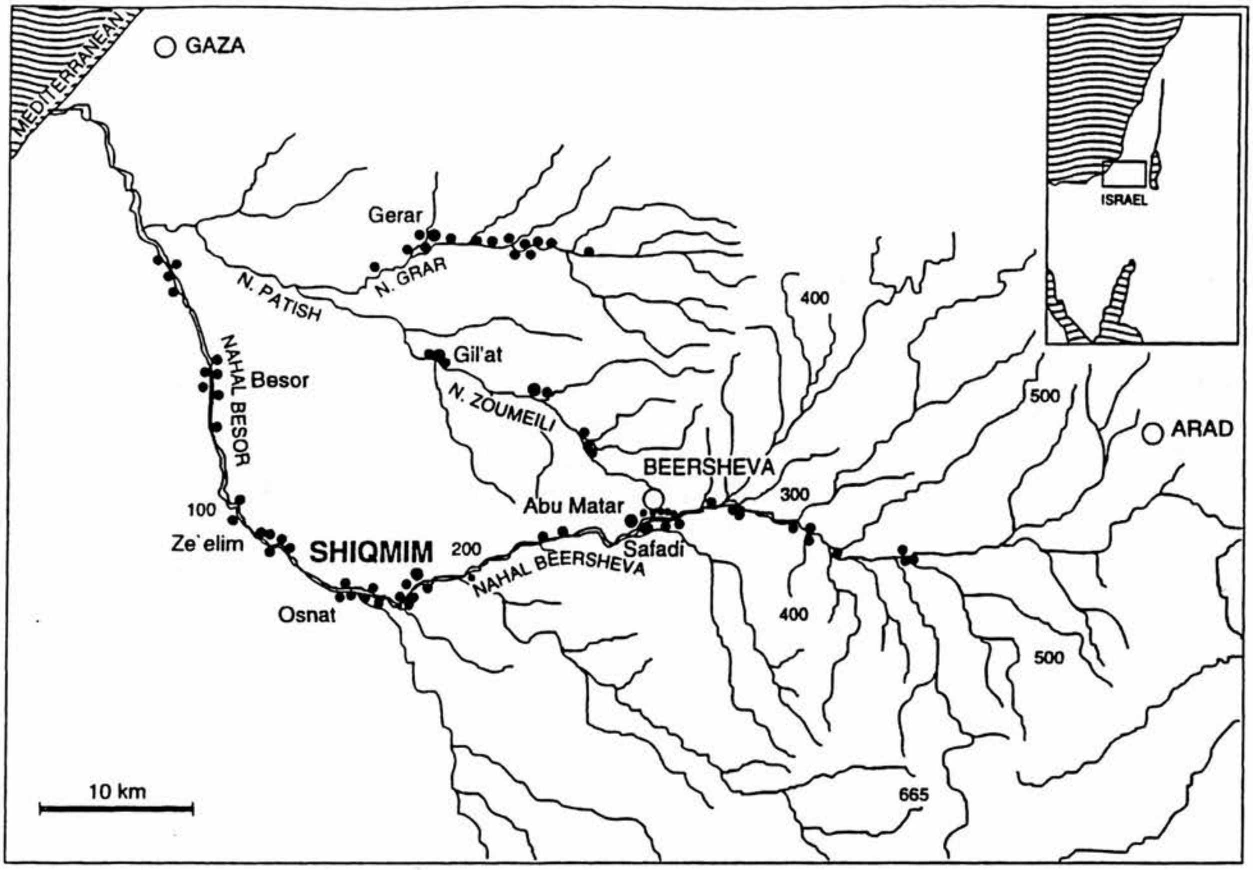


Figure 1. Map of the study area, showing the location of Shiqmim along the Nahal Beersheva in Israel's northern Negev desert.

features being noted. Each bone was given an identification number and entered into an Excel spreadsheet, where the following characteristics were recorded: species, element, fragmentation, side, fusion data, age data, sex, evidence of burning, cut marks, measurements, and contextual data including locus numbers, basket numbers, context description, volume and stratum. The bones were individually numbered in the spreadsheet, but numbers were not written on the bones due to time constraints. After analysis, each group of bones was returned to its original packaging, and the identification numbers of the bones contained within were noted on the outside[4].

**The bones from Shiqmim 1993**

In the 1993 faunal assemblage, the species present and their relative percentages are consistent with those previously noted by Grigson (1987a) for the earlier excavations at Shiqmim. Of the 1558 bones and bone fragments identifiable to species and element, the majority (96.9%) represents domesticates: sheep, goat, cattle, horse (2 bones), and dog (4 bones). The remaining 3.1% of the collection is comprised of remains from wild animals such as gazelle, fox and rodent, as well as a few bones of cat, fish, bird and frog. As in the previous years, no pig bones were found in the 1993 assemblage, the signifcance of which has been discussed at length by Grigson (1989, 1995). Table 1 shows the numbers of bones for each species present in the 1993 collection. A discussion of the various species follows.

[4] Laboratory facilities were generously provided by Prof. Eitan Tchernov, head of the Department of Evolution, Systematics and Ecology at the Hebrew University. The bones from the 1993 excavations at Shiqmim are housed in storage facilties at the Hebrew University/s Givat Ram campus.

| **Species** | **Number** | **% of Total** | |
|---|---|---|---|
| *Domestic Species* | | | *% of Domestic Species* |
| Sheep/Goat (*Ovis aries/Capra hircus*) | 1324 | 85% | 87.7% |
| Cattle (*Bos taurus*) | 180 | 11.5% | 12% |
| Dog (*Canis familiaris*) | 4 | 0.26% | 0.2% |
| Horse (*Equus caballus*) | 2 | 0.13% | 0.1% |
| *TOTAL Domestic Species* | *1510* | *96.9%* | *100%* |
| *Wild Species* | | | *% of Wild Species* |
| Gazelle (*Gazella* sp.) | 12 | 0.8% | 25% |
| Rodent | 10 | 0.7% | 21% |
| Bird (*Aves sp.)* | 9 | 0.6% | 19% |
| Hare (*Lepus sp.)* | 6 | 0.4% | 13% |
| Cat (*Felis sp.)* | 5 | 0.3% | 10% |
| Frog | 3 | 0.2% | 6% |
| Fish | 2 | 0.1% | 4% |
| Fox (*Vulpes vulpes*) | 1 | <0.1% | 2% |
| *TOTAL Wild Species* | *48* | *3.1%* | *100%* |
| **TOTAL** | **1558** | **100%** | |

Table 1. Animal species represented in all identified bones and bone fragments at Shiqmim, 1993.

**Sheep/goat bones**

The sheep/goat distinction

Sheep and goat together comprise 88% of the domestic ungulate bones, and cattle the other 12%. This ratio seems to be typical of the Chalcolithic on the desert fringe, as is shown in Table 2. Differentiating sheep and goat is difficult unless the bones are very well-preserved and the diagnostic parts are present. Due to the highly fragmented state of the Shiqmim bones, sheep and goat are generally lumped together into the category "sheep/goat." When distinction was possible, it was made according to criteria set out in Boessneck (1969) and was attempted only in the instance of bones with well-preserved diagnostic features.

The 1993 sample included a total of 118 bones identified as sheep and 99 as goat, suggesting that, based on the 1993 sample, the average ratio of sheep to goat at Shiqmim was 1.2:1.

| **SITE** | **No. Sh/G** | **% of Total** | **No. Cattle** | **% of Total** | **Total Bones** |
|---|---|---|---|---|---|
| Horvat Hor | 91 | 91% | 9 | 9% | 100 |
| Jawa | 2206 | 91% | 217 | 9% | 2423 |
| T. Ghassoul | 126 | 76% | 41 | 24% | 167 |
| Abu Matar | 153 | 92% | 12 | 8% | 165 |
| Horvat Beter | 156 | 89% | 17 | 11% | 173 |
| Safadi | 3167 | 90% | 314 | 10% | 3481 |
| Shiqmim 82/83 | 458 | 88% | 57 | 12% | 515 |
| ***Shiqmim 93*** | ***1324*** | ***88%*** | ***180*** | ***12%*** | ***1504*** |

Table 2. Representation of sheep/goats and cattle in Chalcolithic sites on the desert Fringe (adapted from Grigson, 1995). Percentages are based on the total number of sheep/goat and cattle bones from each site.

Given the small sample size and the statistically insignificant predominance of sheep[5], we can presume that this ratio reflects a more or less equal number of sheep and goat at the site. Redding (1984) suggests that a ratio between 1:1 and 1.7:1 reflects a herding strategy focused primarily on "herd security". Such a strategy involves the constant maintenance of a breeding population and the minimization of losses due to environmental changes or epidemics, and the assurance of a secure source of meat or other products. Although sheep in general provide more meat than goats, goats are better adapted to an arid environment and have a higher reproductive capacity (Zeder, 1991). It is not surprising, then, that in the arid environment of the northern Negev, the sheep to goat ratio at Shiqmim is nearly equal. This ratio suggests that, in this marginal environment, the inhabitants of Shiqmim aimed their sheep and goat exploitation at securing food rather than maximizing meat or secondary products production.[6]

It is worth mentioning that this nearly equal ratio of sheep to goats is not consistent across the site. In areas E and Z, two of the smaller areas situated on the edge of the site, the sheep to goat ratio is almost 9:1. Whether or not the predominance of sheep in these areas reflects some kind of differential animal exploitation cannot be determined because of the small sample on which this ratio is based (approx. 30 bones).

Sheep/goat age distribution

The age of death of the sheep and goats at Shiqmim was determined through an examination of 31 posterior mandible fragments and mandibular teeth, using criteria established by Payne (1973). Results are shown in a histogram (Fig. 2), where we can see a high kill-off of young animals (0-2 years). Two thirds of the teeth with determinable wear patterns were from animals killed at two years or younger. 40% of the group was killed in the first year of life. Of the remaining animals, almost 50% were killed in the second year, leaving one third of the original sample to survive beyond two years of age.

To confirm the validity of the mandibular tooth eruption data, another method was used to determine the age of death of the sheep/goat from the 1993 assemblage. Using Silver's (1969) epiphyseal fusion age data as a guideline, the various sheep/goat elements for which fusion information could be noted were divided into age categories (Table 3). The numbers of fused and unfused bones in each age category were counted. The percentages of fused and unfused bones in each age category, when listed in ascending order of age (Fig. 3), show a striking resemblance to the kill-off pattern reflected by mandibular tooth eruption (Fig. 2); that is, a high kill-off (over 70%) of the animals under about 2 years of age, with about 30% of the sample being maintained over 2 years.

Many scholars consider the Chalcolithic to be the earliest period with evidence for intensive secondary products usage. Evidence for the exploitation of secondary products is found during the Chalcolithic in artifacts such as the numerous ceramic churns from this time which are seen as evi dence for milking, and spindle whorls which are thought to have been used for spinning fibers (see Sherratt, 1983, Grigson, 1995 and Levy, 1983 for a discussion of secondary products exploitation in the southern Levant). In light of this, the sheep/goat kill-off distribution at Shiqmim might be interpreted as the use of the majority of the animals for meat, while a few females were kept to an older age for reproduction and possibly milking. However, a lack of bones which could be identified as male or female makes it impossible to determine what the sex ratio is in the kill-off distribution from Shiqmim 1993.

A high kill-off of young animals suggests that the economy did not involve the *intensive* production of milk and wool, in the case of which we would find evidence for a larger number of individuals surviving into older years. The inhabitants of Shiqmim may still have produced milk and wool,

[5] A chi-squared test performed on the data, with an expected sheep to goat ratio of 1:1, showed the 0.2 difference to be statistically insignificant.

[6] A secondary product is one which can be taken from the animal while it is alive, such as milk, fibers, and labor.

| Age Category | # Fused | # Unfused |
|---|---|---|
| 10 months (distal humerus, proximal radius, distal scapula) | 65 | 19 |
| 13-16 months (1st phalanx, 2nd phalanx) | 88 | 38 |
| 1.5-2.25 years (distal tibia, distal metacarpus, distal metatarsus) | 27 | 51 |
| 2.5-3 years (calcaneum, distal radius, proximal femur) | 26 | 64 |
| 3-3.5 years (proximal humerus, distal femur, proximal tibia) | 18 | 40 |

Table 3. Numbers of fused and unfused sheep/goat elements in each age category (adapted from Silver, 1969),


Figure 2. Age of death in sheep/goat at Shiqmim '93 (based on tooth eruption and wear, following the method of Payne, 1973).

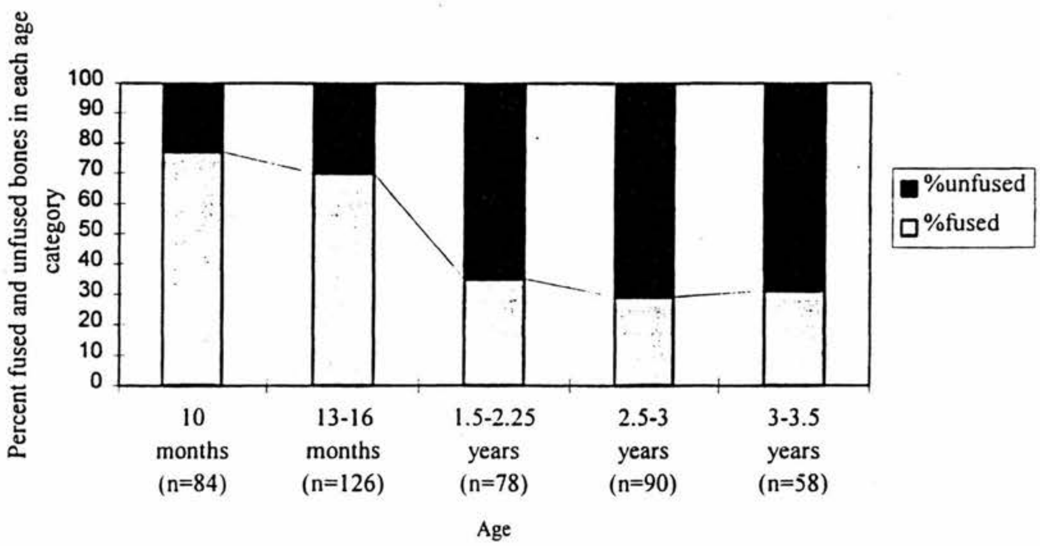


Figure 3. Age of death in sheep/goat, based on epiphysial fusion (fusion ages taken from Silver, 1969).

but based on this study, such secondary product exploitation was less intensive than some scholars believe. Support for this interpretation is found in Davis' (1984) discussion of the Kermanshah faunal sequence. He claims that an economy based on secondary products exploitation (milk and wool) would have a more or less even age distribution, and one based on meat would have a high kill-off of young animals at their peak of meat yield, as is seen in the Shiqmim 1993 teeth and epiphyseal fusion data.

Thus, the predominance of young animals in the age distribution suggests that the sheep/goat at Shiqmim were used primarily for meat. However, we cannot rule-out the possibility of the preservation of some animals for secondary products usage (the presence of cattle at the site reminds us that cows may have been an additional source of milk). In his studies of modern culling strategies in Asvan, Turkey, Payne (1973) found that, in a meat *and* milk economy, males are killed as lambs, and if not, then in their second year, with only a few kept for breeding. Females are mostly maintained, although some are killed in their second year. So, the majority of the meat animals are culled in their second year, the rest being saved for reproduction and milking. In light of Payne's study, the pattern displayed in the Shiqmim 1993 mandibles and epiphyseal fusion data probably reflects meat *and* milk exploitation, not exclusively one or the other.

Horwitz and Smith (1991) gathered metrical evidence for secondary products usage through studies of sheep and goat metapodials from Israel and the West Bank. Their studies show that there was a major decrease in cortical thickness of the bones from the Chalcolithic to the Early Bronze Age. As a decrease in cortical thickness can be thought to reflect an intensification of milk exploitation, it would appear that an increase in milking occurred toward the end of the Chalcolithic or the beginning of the Early Bronze Age. Likewise, culling strategies for the Early Bronze Age show closer to 80% of the sheep/goat surviving into adulthood (Horwitz and Tchernov, 1989), as opposed to only 30% surviving beyond two years of age in the Chalcolithic at Shiqmim 1993. This change in culling practices indicates that in the Early Bronze Age a higher percentage adults were being maintained, possibly for more intensive milk exploitation than was practiced in the Chalcolithic. The culling strategy for sheep/goat at Shiqmim also supports the proposition that *intensive* milking was not practiced in the Chalcolithic in this area, but rather, that the sheep/goat were exploited for a number of products on a less intensive scale.

Sheep as wool providers

Archaeological evidence suggests that people exploited sheep for wool during the Chalcolithic; however, as with milking, the degree of intensification is difficult to determine. A few wool products such as those found (though not in such abundance as linen products) at the Late Chalcolithic site of Nahal Mishmar (Bar-Adon, 1980) provide evidence for wool production at this time. The abundance of spindle whorls from this period might also reflect the exploitation of sheep for their wool, although it is also possible that spindle whorls were used for processing hair, flax or other light, fibrous materials. In her analysis of the sheep and goat bones from Bir es-Safadi, Grigson (1987: Table 1) presents a graph of bone fusion patterns, and uses them to argue that more sheep than goats were kept to old age, probably for milking and wool-production. Figure 4 shows the sheep and goat bone fusion data from Shiqmim, graphed in ascending order of fusion ages (fusion stages taken from Silver, 1969). The inhabitants of Shiqmim probably killed sheep at slightly older ages than goats (a pattern similar to that observed in the Bir es-Safadi data). This marginal preference may suggest the maintenance of sheep for wool production.

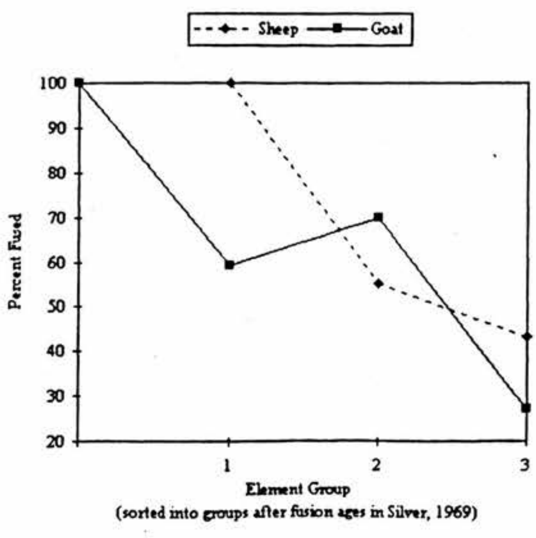


Figure 4. Differential kill-off patterns for sheep and goat (data from Table 4).

| Element Groupings | Raw data sheep | | Raw data goat | | sheep/goat | | Adjusted sheep | | Adjusted goat | | Percent fused sheep | Percent fused goat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | U | F | U | F | U | F | U | F | U | | |
| 1. distal scapula, distal humerus, proximal radius | 12 | 0 | 11 | 3 | 39 | 18 | 32 | 0 | 30 | 21 | 100% | 59% |
| 2. proximal and middle phalanges | 12 | 6 | 23 | 6 | 28 | 23 | | | 41 | 18 | 55% | 70% |
| 3. distal tibia, distal metapodials | 4 | 3 | 2 | 3 | 21 | 42 | 18 | 24 | 9 | 24 | 43% | 27% |
| 4. calcaneum, distal radius, proximal femur | 3 | 2 | 1 | 1 | 17 | 24 | 16 | 26 | 5 | 0 | 38% | 100% |
| 5. proximal humerus, distal femur, proximal tibia | 6 | 5 | 1 | 1 | 14 | 33 | 18 | 33 | 3 | 7 | 36% | 32% |

Table 4: Differential sheep and goat bone fusion patterns at Shiqmim[7]

## Discussion of the age data at Shiqmim

There are a number of complications which must be taken into consideration when making analyses based on the age data from Shiqmim 1993. One is the differential preservation and excavation of bones and teeth. The teeth of younger animals are less likely to preserve due to the fact that they are not as strong as adult teeth. Additionally, they are less likely to be recovered by the archaeologist in excavation due to their small size. Similarly, the bones of adult animals are more likely to survive than the unfused bones of juveniles: unfused or recently fused bones will disintegrate more quickly or be fragmented due to their porous and friable nature. These biasing factors imply that juvenile individuals may be under-represented in the bone assemblage. The prospect that there are even more juveniles from Shiqmim than we see in the present assemblage is a further indication that the economy was primarily meat-based.

Another complication to keep in mind is that the bones and teeth do not come from one context, but from across the entire site and from various loci. This means that the bones and teeth come from deposits of varying antiquity. Therefore the conclusions reached here are general characterizations of caprine exploitation spanning the Late Chalcolithic chronological sequence across the entire area of Shiqmim excavated in 1993. It is thus impossible to paint an exact picture of caprine exploitation at any one point in space and time. While it seems likely that, in general, the inhabitants of Shiqmim did not practice intensive secondary products production, there may be as yet undetected trends toward more milk and wool production throughout the period. Future research based on larger, stratigraphically distinct samples may detect such changes in Shiqmim's chronological sequence.

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[7] Grigson (1987b) stresses the importance of including the fusion data from the bones identified only as sheep/goat because there are more unfused bones in this category. The following formula was used to make proportional adjustments to the Shiqmim data: $a+[(a/(a+b))*c]$. As an example, we will calculate the adjusted number for Element Group 2 fused sheep bones, where a= the number of fused sheep Group 2 bones, b= the number of fused goat Group 2 bones, and c= the number of fused sheep/goat Group 2 bones. Thus the equation is: $12+[(12/(12+23))*28] = 22$ fused sheep bones. Element Groups 4 and 5 have not been included in Fig. 4 due to the negligible number of goat bones in each group.

Sheep/goat Pathologies

Of the 1324 sheep/goat bones, 27 show signs of pathology, primarily oral pathologies. Sixteen sheep/goat teeth have swollen root tips, probably due to a chronic low-grade infection (Baker and Brothwell, 1980). It is thought that periodontal disease such as this is a result of over-grazing, poor nutrients, or crowded grazing conditions where infection spreads easily. It must be mentioned, however, that most of the teeth with swollen roots came from older individuals, suggesting that the infection is related to old age.

A calculus (tartar) build-up was noted on a number of sheep/goat teeth, as reflected in a gold metallic luster on the buccal and/or lingual sides of the teeth. Such calculus may reflect the health and functioning of the teeth (Baker and Brothwell, 1980). Tartar build-up may also mirror the signs of poor grazing conditions (overcrowded or lacking in nutrients) reflected by the swollen roots.

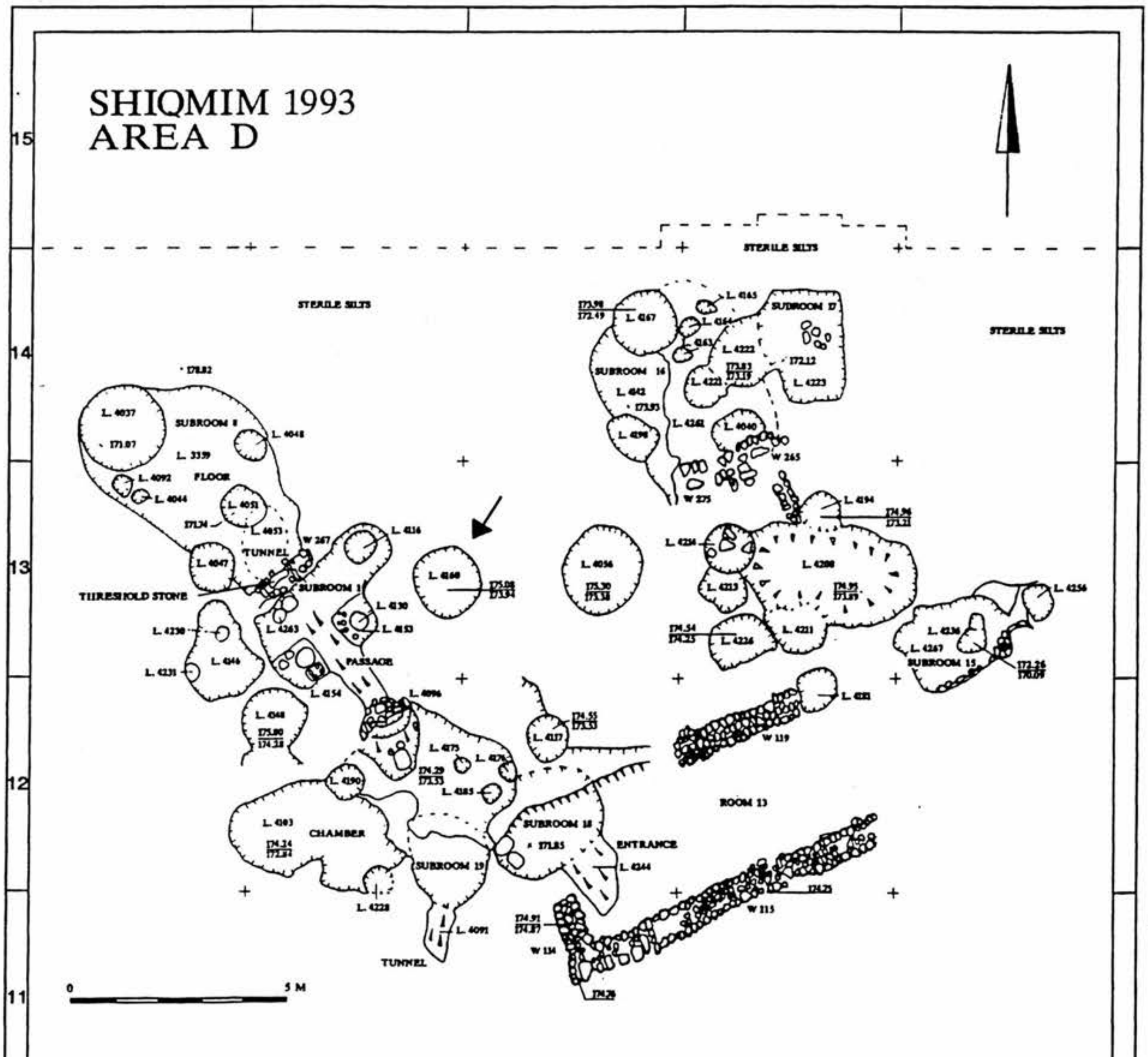


Figure 5. Plan of Area D, the largest excavated area in the 1993 season, indicating the pit (L.4160) in which were found articulating elements of at least four individual sheep/goat and an anthropomorphic bone figurine (see Fig. 6).

Figure 6. Figurine found in L.4160 among articulated remains of at least four individual sheep/goat. The style of this bone figurine, probably made from a cattle scapula, reflects a synthesis of two Chalcolithic traditions: the violin-shape figurine of the Nahal Patish and Lower Jordan Valley, and the ivory statuettes of the Beersheva Valley culture (Levy and Golden, 1996).

**Element representation across the site**

The sheep/goat bone elements represented indicate that whole carcasses were present at the site, since the bone assemblage contains a large representation of both meat-bearing bones (long bones, vertebrae and ribs) and non-meat-bearing bones (cranial bones and extremities). The same type of skeletal area representation is seen in the cattle remains. Cattle are outnumbered by sheep/goat by a ratio of 9:1 in most loci. As the bones were found in similar proportions across the site (that is, most loci produced elements from all regions of the skeleton, both meat-bearing and non-meat-bearing), no distinct meat-processing or discard areas could be defined.

The majority of the animal bone collection from 1993 was found in pits. This is not surprising, as there were a large number of pits found at the site, and we would expect that these pits would be filled with debris, either from discard during occupation, or after the particular feature was abandoned. A characteristic feature of the architecture at Shiqmim is its many subterranean and semi- subterranean rooms. A small number of bones came from the floors and fills of these subterranean rooms and the pits within them.

Almost no bones were found in the tunnels and passageways associated with the subterranean rooms. The fact that so few bones were found in the subterranean rooms may simply result from natural processes of alluvial deposition after abandonment and not to cultural deposition through garbage disposal. During the inhabitation of the site, the rooms might have been used strictly for storage (perhaps of grains) and so would not have been filled with the refuse of food-processing activities. Similarly, if the underground rooms were inhabited by people, they would have been kept clean because household rubbish would only smell and attract flies in the confined area. The tunnels probably remained bone-free because they were used for coming and going, and not for food-processing or discard.

The species and element representation in the pits is fairly even in most loci. There is an average ratio of 9:1 sheep/goat to cattle, all skeletal areas are represented, and most bones within any given context do not clearly articulate. Interestingly, the contents of one pit, L.4160, produced a more distinctive assemblage of bones (see Fig.5, indicating pit L.4160's location in Area D). Over 80 bones were found in this pit, all of which were sheep/goat except for one hare and one rodent bone. The complete or partial remains of at least four individual sheep/goat were found. One adult sheep is represented by long bones, and was over the age of 3-3.5 years at death (aged by a fused proximal tibia). A juvenile or adult goat is represented by articulating phalanges. Two fetal or neo-natal sheep/goat were also found, one represented by a nearly complete skeleton, and another by various entirely unfused hind leg bones. It is of interest that this unique assemblage came from the same pit as the complete anthropomorphic bone figurine described by Levy and Golden (1996);(Fig. 6). This unusual assemblage consisting of articulated individual sheep/goat bones, no cattle bones (which are common in all other contexts), and an anthropomorphic bone figurine, possibly resulted from some kind of ritual activity. The Chalcolithic site of Gilat had a circular "burial monument" which contained nine human skeletons buried above a layer of animal bones (Levy, 1995). However, a lack of data pertaining to the relationship of animal bones to features and architecture at other Chalcolithic sites in the southern Levant makes it difficult to make inter-site comparisons.

**The Shiqmim cattle: meat-providers or beasts of burden?**

There is tentative evidence from Chalcolithic sites in the southern Levant for the use of cattle for products other than meat. A sandal made from cow-hide found in a Late Chalcolithic deposit at Nahal Mishmar (Bar-Adon, 1980) attests to the use of cattle for the primary product of leather at this time. As for secondary products, the "churns" found at many northern Negev sites may be interpreted as vessels for sheep/goat milk as well as cow milk. If sheep/goat were being milked, then it would have been logical to milk cattle as well for, as Grigson (1995) has stressed, one cow produces much more milk than one sheep/goat. Excavations at Ein Gedi yielded artistic evidence relating cattle to milk products in the form of a ceramic bull with a churn on its back (Ussishkin, 1980). This figurine attests to some kind of relationship between cattle and milk products, as well as the use of cattle for labor. So it seems that, during the Chalcolithic, cattle were, indeed, exploited in a number of ways: they provided primary products such as meat and leather, as well as secondary products such as milk and labor. Unfortunately, the small size of the Shiqmim cattle bone assemblage (180 bones) makes it difficult to derive definitive archaeozoological evidence as to how cattle were exploited.

Cattle as meat providers

Although the sample size of Shiqmim cattle bones is small, we attempted an analysis of age and body part representation. This type of analysis can help in assessing whether or not cattle were culled for meat or maintained for other purposes. If cattle were being raised solely for meat, we would see a kill-off pattern similar to sheep/goat; that is, many animals being killed young at their peak of meat-yield and a select few being kept alive for breeding. An assessment of the epiphyseal fusion of the cattle bones in the Shiqmim 1993 collection (Fig. 7, Table 5) reveals that a majority of the cattle was killed by 3.5 to 4 years of age (only 25% of the represented individuals in this bracket have fused bones). There is a significant drop in the percentage of fused bones from 2.5 to 3.5 years, implying the slaughter of cattle at their peak of meat-yield, with very few individuals maintained to older ages. This indicates that cattle were not used exclusively or even primarily for labor (in which case we would see a much higher percentage of mature animals) but were more likely butchered for meat and skins.

The most convincing evidence for cattle being used for meat at Shiqmim is seen in cut marks on an articulating group of limb bones (calcaneum, astragalus, centroquartal and metatarsal) found in a pit. The calcaneum and astragalus have heavy cut marks on the lateral side, indicating an attempt to sever the extremity from the meat-bearing upper limb. The unfused calcaneum reveals that the animal was less than three years old when it died, suggesting that it was intentionally killed at a young age.

Cattle as beasts of burden

The cattle bone fusion patterns, body part representation, and butchery marks discussed above imply that cattle were used primarily as meat animals at Shiqmim. Additionally, because of their size, cattle can provide up to 9 times the meat of sheep/goat (based on meat-weight calculations in Clark and Yi, 1983; Grigson, 1995). Thus, if cattle at Shiqmim were being raised primarily for meat, they would have actually provided more meat than the sheep/goat in the sample. However, in a marginal environment such as that of the Negev fringe, maintaining cattle solely as a source of meat is not as practical as maintaining sheep/goat. Sheep/goat are better adapted to arid environments (especially goat), they are smaller and less meat-yielding, and so could be immediately eaten without requiring preparation for long-term storage. Relying on sheep/goat as a main source of meat is a more practical solution than investing in a high-maintenance population of cattle which would be difficult to maintain with limited water and grazing space. This leads us to consider the possibility that cattle were maintained for some purpose in addition to meat-production which would make raising them a worthwhile investment.

Cattle offer a unique and substantial secondary product, that of labor, as animals for carrying loads or pulling ploughs. Archaeological evidence for cattle being used for labor is seen in such artifacts as the ceramic bull from Ein Gedi carrying two churns, mentioned earlier in the text. Evidence is found in the assemblage of animal bones from Shiqmim 1993 in the form of a distal metacarpal with an expanded articulation and lesions caused by abrasion with the proximal phalanx. A similar metapodial with osteoarthritis was identified by Grigson from an earlier season of excavation at Shiqmim (Grigson, 1987a, 1989; Levy *et al*, 1991: 408). Although pathologies such as this could simply result from old age, they might also be a result of strain brought on by cattle being used to pull or carry heavy loads. The tentative osteological evidence for cattle as beasts of burden is outweighed in this case by the bone fusion data, which imply that cattle were primarily used for meat (and skins). However, it is an indication that cattle might have been exploited for labor as well, although not to an extent which can thus far be detected in the bone remains.

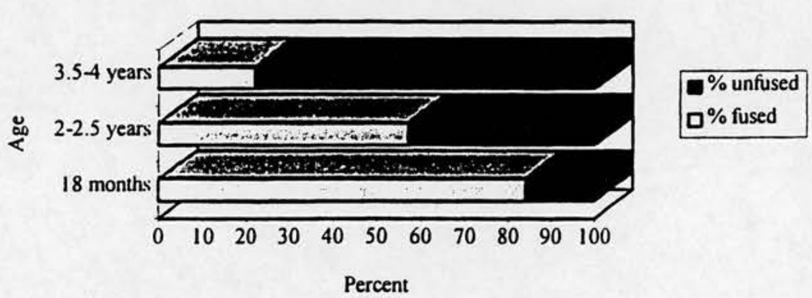


Figure 7. Age of death in cattle, based on epiphysial fusion (fusion ages taken from Silver, 1969).

| Age of Fusion | # Fused | # Unfused |
|---|---|---|
| 18 months (proximal radius, 1st phalanx, 2nd phalanx) | 16 | 3 |
| 2-2.5 years (distal metapodials, distal tibia) | 4 | 3 |
| 3.5-4 years (calcaneum, proximal femur, proximal humerus, distal radius, proximal ulna) | 2 | 7 |

Table 5: Numbers of fused and unfused cattle elements at Shiqmim 1993 (based on Silver, 1969).

It must be remembered that the preceding discussion is based on a relatively small number of cattle bones, from which no certain conclusions can be drawn. The ideas put forth can merely be considered *suggestions* as to the economic uses of cattle at Shiqmim, a topic which might be further elucidated by an analysis of the entire assemblage of cattle bones from the cumulative years of excavations at Shiqmim.

**Other species**

Gazelle

The 12 gazelle bones from the 1993 excavations were not concentrated in any particular area or locus. They were not identified to species level, but are most likely of the desert species *Gazella dorcas*. All the bones identified are from the head (mandibles and a horncore from the outlying site of Metzad Aluf), ankle (astragalus) and feet (a metacarpal and phalanges). There are too few gazelle bones in the 1993 assemblage to suggest that the head and lower-limb bones were brought to the site in the form of skins. Most likely, the lack of meat-bearing bones is due to difficulties encountered with the distinction of broken vertebrae and limb bones of gazelle, from those of sheep/goat. A much larger sample of gazelle bones is needed in order to make any conclusions about the role of gazelle at Shiqmim. The presence of bones of gazelle and other wild animals suggests that a certain degree of hunting or trading was being practiced at Shiqmim, but according to the small number, the skins and meat of hunted animals were not critical economic factors.

Horse

It has been argued that domestic horses were already present in the Negev in the fourth millennium (Grigson, 1993), and new finds from Shiqmim 1993 give further support to this suggestion. Although no bones of other equid species were found, two horse (*Equus caballus*) bones were in the 1993 sample. One radius was interred in a stratum I deposit (topsoil), and so its antiquity is not certain. Another bone, a proximal humerus, was found in a secure stratum IIa locus among articulated sheep/goat bones, suggesting it had remained relatively undisturbed since its deposition. The humerus has a Bp (proximal breadth) of 92.8mm, a similar size to the proximal humerus of a horse identified by Grigson in Shiqmim 1989, whose Bp is 92.6mm. We can only guess what the function of horses in the Chalcolithic might have been. It is thought that cattle were used before horses for draught, and that horses were not used to pull vehicles until the late third millennium (Sherratt, 1983), and were not ridden until the first millennium BC (Clutton-Brock, 1987; Grigson, 1995). The presence of horse in such small numbers at Shiqmim suggests that the horse was not yet common, and may have even been an item of prestige because of its rarity. Unfortunately, the few remains give us no clues as to their use. The horse remains of this period, however infrequent, raise important questions as to the timing, mechanism and route of the arrival of a small number of horses (perhaps some of the earliest domestic horses, originating in the steppes of central Asia) into the southern Levant during this period.

**Conclusions**

The bones from Shiqmim 1993 reflect an economy based on sheep/goat and cattle, mainly for meat, but possibly also for secondary products such as milk, labor, hair and wool. Redding (1984) argues that a sheep to goat ratio of between 1:1.7 and 1:1 indicates that the herd was structured for herd security, and that optimal kill-off to promote herd security is between 0.5-2 years of age. The sheep to goat ratio at Shiqmim 1993 is 1.2:1, and the kill-off of the majority of animals is under 2 years, suggesting that the structure of herds at Shiqmim was mainly directed toward promoting herd security. The sheep/goat cull pattern at Shiqmim 1993 indicates that these animals were exploited mainly for their meat. However, ceramic evidence (churns and spindle whorls) suggests that the inhabitants of Shiqmim did exploit their livestock to some degree for milk and wool production, but given the archaeozoological evidence discussed here, the scale of secondary products exploitation was not intensive. In light of the present evidence from the 1993 animal bone collection, sheep/goat exploitation was not focused exclusively on meat, milk or wool production, but combined all three products and emphasized herd security.

Bone fusion data suggest that cattle were also used mainly as a source of meat. Cut marks on a small number of cattle bones provide evidence for the butchery of certain individuals for food. However, the presence of ceramic "churns" in the Chalcolithic and such zoomorphic representations as a figurine of a cattle laden with churns, imply that cattle may have been used for milk production. The discovery of cattle metacarpals with lesions possibly resulting from forelimb strain gives *some* support to the hypothesis that cattle were used as beasts of burden. However, as in the case of sheep/goat, intensive secondary products exploitation seems unlikely, given the cattle bone fusion data. The inhabitants of Shiqmim probably raised cattle with multiple and generalized purposes in mind.

Although the Shiqmim 1993 faunal bone assemblage is relatively abundant, it will be most useful incorporated into a study of spatial and chronological changes throughout the entire human occupation of Shiqmim. This discussion has touched on archaeozoological issues such as the relative importance of sheep versus goat at Shiqmim and the nature and extent of secondary products exploitation of sheep/goat and cattle during the Late Chalcolithic in the northern Negev Desert. The noted absence of bone refuse in tunnels and subterranean rooms, as well as the unusual contents of a pit consisting of articulated bones of individual sheep and goats and an anthropomorphic bone figurine, encourages the further study of taphonomic processes and potentially ritual human activities at Shiqmim. Finally, the discovery of another proximal humerus of a horse at Shiqmim merits further research into the role of the horse in Chalcolithic society and economy. Future archaeozoological studies will enhance these preliminary observations, which deal with but a few of the key economic issues having to do with the rise of social complexity in the northern Negev Desert at this time.

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